Strategic Regional Water Resource Solutions: Detailed Feasibility and Concept Design

Standard Gate Two Submission for River Severn to River Thames Transfer (STT)

Date: November 2022

SEVERN TRENT · Thames Water · United Utilities

Position Statement

This document has been produced as part of the process set out by RAPID for the development of the Strategic Resource Options (SROs). This is a regulatory gated process ensuring control and appropriate scrutiny on the activities that are undertaken by the water companies to investigate and develop efficient solutions, on behalf of customers to meet future drought resilience challenges.

This report forms part of the suite of documents that make up the 'Gate 2 Submission'. That submission details the work undertaken by Thames Water, Severn Trent Water and United Utilities in the ongoing development of the proposed SROs. The intention of this stage is to provide RAPID with an update on the concept design, feasibility, cost estimates and programme for the schemes, allowing decisions to be made on their progress and future funding requirements.

Should a scheme be selected and confirmed in the companies' final Water Resources Management Plan, in most cases it would need to enter a separate process to gain permission to build and run the final solution. That could be through either the Town and Country Planning Act 1990, or the Planning Act 2008 development consent order process. Both options require the designs to be fully appraised and, in most cases, an environmental statement to be produced. Where required that statement sets out the likely environmental impacts and what mitigation is required.

Community and stakeholder engagement is crucial to the development of the SROs. Some high-level activity has been undertaken to date; however, much more detailed community engagement and formal consultation is required on all the schemes at an appropriate point. Before applying for permission, Thames Water, Severn Trent Water and United Utilities will need to demonstrate that they have presented information about the proposals to the community, gathered feedback and considered the views of the stakeholder. We will have to consider this feedback and, where appropriate, make changes to the design as a result.

The SROs are at a very early stage of development, despite some options having been considered for several years. The details set out in the Gate 2 documents are still at a formative stage and consideration should be given to that when reviewing the proposals. They are for the purposes of allocating further funding not seeking permission.

Disclaimer

This document has been written in line with the requirements of the RAPID Gate 2 Guidance and to comply with the regulatory process pursuant to Thames Water's, Severn Trent Water's and United Utilities' statutory duties. The information presented relates to material or data which is still in the course of completion. Should the solution presented in this document be taken forward, Thames Water, Severn Trent Water and United Utilities will be subject to the statutory duties pursuant to the necessary consenting processes, including environmental assessment and consultation as required. This document should be read with those duties in mind.

Contents

Glossary and Abbreviations

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Glossary	
Cotswold Canals	Partially refurbished canal network and associated infrastructure (including pumping stations, bypass pipework, treatment plant and pipeline) with design capacity of 300Ml/d to convey river water from River Severn to River Thames.
Deerhurst Pipeline	Pipeline and associated infrastructure (including pump station, treatment plant, break pressure tank) with design capacity of 300/400/500Ml/d to convey river water from River Severn to River Thames.
Hands off Flow	This is the flow below which abstractions from the River Severn are restricted or not permitted
Interconnector	Term used to describe infrastructure required to convey river water from River Severn to River Thames. The Interconnector options are the Deerhurst Pipeline or Cotswold Canals.
Interconnector design capacity	Raw water volume abstracted from the River Severn at the start of the Interconnector. Not the volume delivered to the River Thames at the end of the Interconnector and not the Deployable Output of the STT system.
Minworth SRO	Minworth WwTW effluent transfer to the River Avon (covered under Severn Trent Water (STW) Minworth SRO developed by Severn Trent and Affinity Water). This has the capacity to release up to 115Ml/d into the River Avon.
Mythe Abstraction Licence	Mythe Water Treatment Works (WTW) source support element (covered under Severn Trent Sources SRO developed by STW). Unused abstraction licence transfer has the capacity to release 15Ml/d into the River Severn.
Netheridge Wastewater Treatment Works	Netheridge Wastewater Treatment Works (WwTW) source support element (covered under Severn Trent Sources SRO developed by STW). Effluent diversion has the capacity to release up to 35Ml/d into the River Severn.
Source support elements	Elements which have the potential to make additional raw water resources available for abstraction at the start of the Interconnector.
STT partners	The three companies promoting this SRO i.e. Severn Trent Water, United Utilities and Thames Water
STT SRO	Comprises the Interconnector, the River Vyrnwy Bypass Pipeline, Shrewsbury Redeployment and conveyance of the source support elements through the river systems (Vyrnwy, Severn, Avon, and Thames).
STT system	Comprises the STT SRO plus STT source support elements that together form an operational system.
STT system operating strategy	Description of contribution/operation of source support elements and river systems to form an operational system.
Supported flow	When the flow in the River Severn is below the hands-off flow rate at which point abstraction from the River Severn may lead to unacceptable environmental impacts downstream. To mitigate these environmental impacts a permitting strategy is being developed whereby additional water put into the River Severn can be abstracted for a Severn to Thames transfer. The additional water is referred to as Supported flow
Unsupported flow	Unsupported flow occurs when the flow in the River Severn is above the hands-off flow rate and raw water can be freely abstracted from the River Severn for transfer to the River Thames
Vyrnwy Mitigation – River Vyrnwy Bypass Pipeline	Pipeline from Oswestry to the River Severn. The release of partially treated water via the bypass pipeline is a mitigation measure to the River Vyrnwy from the Vyrnwy Release source support element. The pipeline has the capacity to convey up to 155Ml/d.
Shrewsbury Redeployment	Shrewsbury Redeployment is facilitated by a supply from Oswestry. This allows the reduction in the abstraction at Shelton of 25Ml/d.
Vyrnwy Release	Lake Vyrnwy source support element (covered under North West Transfer SRO developed by United Utilities). This source has a capacity of up to 180Ml/d. A direct release of 25Ml/d into River Vyrnwy.
Abbreviations	
1880 Act	The Liverpool Corporation Act 1880 which authorises the discharge of compensation water from the Vyrnwy Reservoir into the River Vyrnwy
ACWG	All Company Working Group
AEoI	Adverse Effect on Integrity
AIC	Average Incremental Cost
AMP	Asset Management Plan
BaU	Business as Usual
BNG	Biodiversity Net Gain

CAP	Competitively Appointed Provider
CAPEX	Capital Expenditure
DCO	Development Consent Order
DO	Deployable Output
DPC	Direct Procurement for Customers
DWI	Drinking Water Inspectorate
EA	Environment Agency
EIA	Environmental Impact Assessment
HoF	Hands off Flow
HRA	Habitat Regulations Assessment
IEA	Initial Environmental Appraisal
Ml	Mega litres
Ml/d	Mega litres per day
INNS	Invasive Non-Native Species
ITT	Invitation to Tender
IVM	Investment Modelling
NC	Natural Capital
NE	Natural England
NPV	Net Present Value
NRW	Natural Resources Wales
NSIP	Nationally Significant Infrastructure Project
NWT	North West Transfer SRO
OPEX	Operational Expenditure
PMB	Programme Management Board
RAPID	Regulatory Alliance for Progressing Infrastructure Development
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SESRO	South East Strategic Reservoir Option
SIPR	Specified Infrastructure Projects Regulations
SMNR	Sustainable Management of Natural Resources
SRO	Strategic Resource Option
STT	River Severn to River Thames Transfer
STW	Severn Trent Water
SWQRA	Strategic Water Quality Risk Assessment
T2AT	Thames to Affinity Transfer
T2ST	Thames to Southern Transfer
TW	Thames Water
UU	United Utilities
WFD	Water Framework Directive
WRMP	Water Resource Management Plan
WRSE	Water Resources South East
WRW	Water Resources West
WTW	Water Treatment Works
WwTW	Wastewater Treatment Works

1 Executive summary

1.1 The River Severn to River Thames Transfer (STT) Gate 2 solution offered is a robust, mature, scalable, and strategic option to improve resilience to drought. The STT Strategic Resource Option (SRO) comprises an interconnector, the River Vyrnwy Bypass Pipeline, Shrewsbury Redeployment and conveyance of the source support elements through the river systems (Vyrnwy, Severn, Avon, and Thames). The STT SRO plus the source support elements together form the STT system.

1.2 Considerable work has been undertaken in Gate 2 on options appraisal, environmental assessment, commercial operation, permitting, and stakeholder engagement to reduce the uncertainties from Gate 1 and meet the Gate 2 expectations.

1.3 In Gate 2 we have reduced the proposed direct release from Lake Vyrnwy from 75 to 25 mega litres per day (Ml/d). This avoids adverse impacts on the environment while still allowing sufficient headroom for the required compensation releases as stipulated by the Liverpool Corporation Act 1880 which authorises the discharge of compensation water from the Vyrnwy Reservoir into the River Vyrnwy (1880 Act).

1.4 The project involves no construction in Wales but does have an interaction with its environment and, as noted in the Welsh Government's Water Strategy for Wales, will aim to maintain, and enhance the resilience of ecosystems and the benefits they provide. Therefore, while there are no works proposed in Wales, Welsh stakeholders will remain key in the management of environmental impacts.

1.5 In addition, following work undertaken in Gate 2 as part of the North West Transfer Strategic Resource Option (SRO) being promoted by United Utilities (UU), an additional 25Ml/d can now be released into the River Severn. This increases the Vyrnwy/Shrewsbury source capacity from 180Ml/d in Gate 1 to 205Ml/d for Gate 2.

1.6 The STT SRO has been included in the regional plan modelling and is on the preferred and alternative pathways in the draft regional plans.

1.7 The Water Resources South East (WRSE) draft regional plan has selected a 500Ml/d interconnector option in 2050 as the preferred transfer capacity. The support elements of the STT system come online in a phased manner thereafter. The Shrewsbury and Mythe sources are not currently available for transfer. They are needed to resolve a deficit in the Water Resources West (WRW) draft regional plan.

1.8 Following a thorough and robust options appraisal process the Interconnector concept design has advanced. The Deerhurst Pipeline is currently preferred for the transfer infrastructure as it meets the preferred transfer capacity and provides the best value solution. However, we will consult on our preferred option and alternatives in Gate 3.

1.9 We have broadened our stakeholder engagement through Gate 2, engaging with interest groups, local authorities, and Welsh stakeholders. The transfer is generally receiving positive support and we are reflecting stakeholder feedback in our plans.

1.10 Natural Resources Wales (NRW) has confirmed the maximum release from Lake Vyrnwy permitted under existing Acts and Orders is 405Ml/d. The proposed release direct from Lake Vyrnwy falls well within this limit. The interpretation of this is that there is no requirement to seek to amend the 1880 Act in order to permit the STT. A permitting road map is being developed in consultation with regulators to support the SRO development.

1.11 We have examined the available evidence and data to determine the potential environmental effects of implementing and operating the STT SRO. Where the assessments identified the potential for adverse effects, we have followed the mitigation hierarchy to avoid impacts or proposed mitigation measures. These include an alternative Vyrnwy Bypass to the River Severn and a reduced direct release volume from Lake Vyrnwy. Several major beneficial effects have been identified in respect of providing additional water resources, creating opportunities for enhanced biodiversity value, and/or economic benefits.

1.12 Based on the outcomes of the assessments undertaken there are no 'showstoppers' to indicate that the STT system operation is not feasible due to environmental reasons, at this stage. Recommendations have been made to increase confidence in the conclusions, and to resolve remaining uncertainties during the formal environmental assessments as part of the consenting process.

1.13 We have developed a commercial and operational strategy for the system. A working model is now in place which addresses the complexities, and this will mature through Gates 3 and 4.

1.14 The project finances have been carefully managed through Gate 2. This has been achieved by adopting a lean core management team and partnering with others to procure work with common scope and objectives. Competitive tendering has been used for 85% of the supply chain workstream activities. This cost-efficient approach has resulted in over 30% saving when compared to the budget.

1.15 The recommendations and actions received from the Regulatory Alliance for Progressing Infrastructure Development (RAPID) and feedback from stakeholders from the Gate 1 assessment have been reflected in the SRO development.

1.16 The timeline for Gate 3 is based on ensuring STT could be "construction ready" in AMP8 (2025 to 2030), if required. However, other later delivery timescales may be appropriate which will be confirmed once the regional and Water Resource Management Plan (WRMP) 24 plans are finalised in 2023. A flexible approach is therefore proposed with a "Mid-Gate3 Checkpoint" at the end of 2023 to confirm and adjust the direction of the project, as appropriate, once the WRMP24 plans are finalised.

1.17 An external third line assurance review was carried out in the context of RAPID's assessment criteria for robustness, consistency, and uncertainty. They concluded that the STT submission satisfies the Gate 2 criteria.

1.18 This SRO is supported by the board of each of the partner companies. The STT partners are ready and committed to proceed to Gate 3 and have identified appropriate project governance, funding, activities, and outcomes for the next stage of the SRO development. We are therefore recommending that this proposal should proceed to Gate 3.

Key facts for STT

Topic	Key facts	Chapter
Preferred Options	The Deerhurst Pipeline is currently preferred for the Interconnector. A 500Ml/d transfer capacity is preferred in the regional plan with sources phased over the life of the plan.	3
Earliest Delivery Date	The earliest that construction-ready status could be achieved for the SRO would be by Q3 2028 and by Q3 2033 for commissioning completion.	7
Deployable Output (DO)	The deployable output to the south east that the STT system can provide is 354Ml/d as an average and 447Ml/d peak (based on a 500Ml/d pipeline interconnector).	4
Cost	Cost estimates for the pipeline options including CAPEX, OPEX, NPV and AIC values have been derived. CAPEX is in the range of £975m to £1270m. All estimates include optimism bias and costed risk. CAPEX costs remain relatively consistent with costs at Gate 1.	8
Environment	Where the assessments identified the potential for adverse environmental effects, we have followed the mitigation hierarchy to avoid impacts or proposed mitigation measures. Embodied (capital) carbon for the STT SRO is in the range of 229tCO2e to 303tCO2e.	6
Water Quality Risks	The Gate 1 Strategic Water Quality Risk Assessment has been updated in light of new water quality data from the SRO monitoring programme. New limiting hazards have been included at Gate 2. For most of the limiting hazards, the residual risks posed to consumer are low.	5
Planning Issues	The Interconnector would be a nationally significant infrastructure project (NSIP) and therefore the proposed planning strategy is to consent the Interconnector through Development Consent Order (DCO). Netheridge may be required to be included as 'associated development'. Vyrnwy Bypass and Shrewsbury Redeployment would not meet the descriptions and thresholds for an automatic NSIP. These elements would either be consented through Town and Country Planning Act applications or at least in part permitted development depending upon the scope of the proposed development and need for EIA.	7
Interconnector Procurement	The Gate 2 process has concluded that while the STT System is not considered to be suitable as a Direct Procurement for Customers (DPC) in its entirety, the Interconnector is seen as an element of the STT system which is suitable for a DPC. Thames Water are considered the party who would take forward the delivery of the Interconnector as the Appointee and contract with a CAP accordingly.	7
Key Risks	The SRO is considered to be viable and there are no major barriers to its progression identified at this stage. No red risks were identified following mitigation.	7

2 Background and objectives

Background

2.1 The Water Resources Long Term Planning Framework 2016 by Water UK highlighted the “significant and growing risk of severe drought impacts arising from climate change, population growth and environmental drivers” in England. This work was developed by the National Infrastructure Commission and reported in their publication Preparing for a drier future: England’s water infrastructure needs (2018). In 2019, Ofwat published a final determination on Price Review (PR19) which gave an allowance “to progress the development of strategic regional water resource solutions, including the River Severn to River Thames transfer”.

2.2 The STT is one of several SROs that will address the challenges posed in the Environment Agency (EA) policy document Meeting our Future Water Needs: A National Framework for Water Resources, 2020. The SRO programme is currently being considered under the RAPID gated process. The STT SRO is under consideration, as part of a portfolio of solutions, to ensure that a reliable and resilient water supply is provided to water-stressed areas and in particular the southeast of England.

2.3 This SRO also takes a step towards the national transfer network first noted in the National Infrastructure Commission report in 2018 by promoting a transfer of water from Water Resources West (WRW) region to the WRSE region.

2.4 The project involves no construction in Wales but does have an interaction with its environment. Therefore, as noted in the Welsh Government’s Water Strategy for Wales, we will aim to maintain, and enhance the resilience of ecosystems and the benefits they provide.

2.5 The infrastructure design was developed in Gate 2 in compliance with the All Company Working Group (ACWG) publication on Design Principles for Strategic Resource Options. The goal of the document is to ensure that we look beyond the project limits when searching for possibilities to mitigate climate change, improve the quality of life for those who work and live nearby, use the infrastructure to enhance the natural and built environment, and achieve multiple benefits where possible. This was taken into account for STT by bringing together various professions and talents to the team in order to establish a 'system' approach to resolving difficulties and proposing benefits. The application of the Design Principles is contained in the Interconnector and Vyrnwy Bypass CDR Annexes.

2.6 The STT's design concept is to offer water supply resilience to the South East of England during droughts while using and improving water resources across the UK, with the potential to adapt to future requirements, and leave a positive legacy for the environment and people.

2.7 The Gate 1 submission for the STT SRO was submitted in July 2021. The submission recommended that the SRO proceed to Gate 2 and RAPID agreed with that recommendation in their approval of September 2021.

2.8 In coming to their conclusion, RAPID noted several recommendations and actions. These are detailed in Table 2-1 along with the responses and signposting to where further detail is included in this report.

Objectives

2.9 The objective of this Gate 2 analysis is to enable the development of a cost-effective strategy for moving water from WRW to WRSE in order to provide resilience to a 1 in 500-year drought. In doing so, the opportunities and benefits of this solution should be maximised and any risks managed to ensure that a practical and promotable solution is proposed.

2.10 The solution proposed is in line with the previous national reports in that it promotes a national transfer network in England and promotes an inter-region water transfer.

Table 2-1 Recommendations and Actions from Gate 1 with commentary

Actions – to be addressed in Gate 2 submission			
Number	Section	Detail	Comment
1	Solution Design	Ensure Welsh stakeholders and customers are included in solution-specific engagement.	Gate 2 engagement with Welsh and other stakeholders carried out is detailed in Chapter 9.
2	Costs & Benefits	Further work is required on elements of the solution which impact on Wales	Further work has been carried out on the Wales eco-system and as a result the

		ecosystem resilience. This will achieve sustainable management of natural resources (SMNR) as well as helping to achieve goals set out in the Well-being of Future Generations (Wales) Act 2015. Any proposal which has implications for Wales must meet the requirements of this Act and the Environment (Wales) Act 2016. This is in addition to the natural capital and biodiversity net gain (BNG) requirements for England.	release volume from Lake Vyrnwy to the River Vyrnwy has been reduced in Gate 2. No works are proposed in Wales but environmental and permitting considerations for the Vyrnwy discharge, SMNR, BNG, and implications on the Severn Estuary SAC are described in Chapters 6 and 7.
3	Costs & Benefits	Present the outcomes of the resilience assessments of the solution in submission documents, with a focus on comparisons between the routing options. Investigate multi-sector benefits the solution could provide. The solution also needs to consider the benefits to Wales as required under Welsh legislation.	Options appraisal assessments and a wider multi-sector benefits analysis associated with the Cotswold Canals have been carried out. These are described in Chapter 3 and Options Appraisal and CDR Annexes. Environmental benefits to Wales are described in Chapter 6.
4	Programme & Planning	Demonstrate full understanding of the risks to the solution from potential regulatory barriers; this includes risks and issues associated with the Habitats Regulations.	Work undertaken to understand the HRA and permitting issues are described in Chapter 6 and 7. It is noted that a change to the 1880 Act is unlikely to be required.
5	Environment	Ensure environmental assessments comply with the Environment (Wales) Act 2016 and Well-being of Future Generations (Wales) Act 2015.	Environmental assessments comply with all relevant Acts and are detailed in Chapter 6.
6	Environment	Investigate the impact of the solution on the integrity of the Severn Estuary Special Area of Conservation.	Assessments have been conducted and liaison carried out with regulators (e.g., EA, NRW) on the SAC is detailed in Chapter 6.
7	Environment	Illustrate the relationship between carbon reduction, sector net zero commitments and solution design and delivery choices. Show methods used for carbon calculation, considering framework and national policy guidance.	The carbon assessment is in compliance with the relevant national policies and frameworks and is discussed in Chapter 6 and detailed in the associated carbon Annex.
Recommendations for Gate 2 submission			
Number	Section	Detail	Comment
1	Solution Design	Ensure relationships with receiving SROs in the south east are closely managed, and the communication of benefits to each solution are aligned (for example with the South East Strategic Reservoir Option (SESRO).	Engagement with WRW, WRSE and relevant SROs (e.g., SESRO, T2ST) has been ongoing throughout the Gate 2 process and referenced in Chapter 3 and 4.
2	Solution Design	Develop a stakeholder engagement plan, including wider and local stakeholders once decision on preferred route has been made.	Engagement with stakeholders has continued in Gate 2 and an engagement plan is detailed in Chapter 9.
3	Costs & Benefits	Further integrate social and amenity values into a costs & benefits assessment of the solution. Provide specifics on work being undertaken to adhere to Welsh legislation.	This was considered in a wider multi-sector benefits analysis as part of the options appraisal analysis and 'potential futures' assessment and is detailed in the Options Appraisal Annex for the Interconnector. Work necessary to adhere with Welsh legislation is detailed in Chapter 6
4	Costs & Benefits	Further explore uncertainties in Deployable Output modelling following WRSE modelling outputs and River Severn to River Thames transfer model build, including the solutions unsupported flow assumptions. We acknowledge this is being incorporated into Gate 2 activities.	A detailed account of the work undertaken to explore uncertainties in Deployable Output and water resource modelling is provided in Chapter 4.
5	Costs & Benefits	Investigate and present potential wider resilience benefits of the solution, beyond the resilience of the solution itself, even if these opportunities are limited by the solution type.	Investigations were carried out on wider resilience benefits and are presented in detail as part of the options appraisal analysis and are detailed in Chapter 4, 6, and the Options Appraisal Annex for the Interconnector.

3 Solution design, options and sub-options

3.1 The STT SRO enables a transfer of water from the River Severn to the River Thames. The SRO forms part of the STT system. The scope of the SRO has developed as a result of the considerable work carried out in Gate 2. The STT SRO is described below and illustrated geographically in Figure 3-1:

STT SRO

- **Interconnector**: the treatment and transfer of flows from the River Severn to the River Thames.
- **River Vyrnwy bypass pipeline** that connects flows from Lake Vyrnwy at Oswestry to the River Severn, thus mitigating any environmental impacts in the River Vyrnwy.
- **Shrewsbury Redeployment**: the provision of 25Ml/d of treated water supply to Shrewsbury from the North West Transfer SRO. This will release flows into the River Severn that were previously abstracted to supply Shrewsbury.

Due to the risk of concurrent droughts in both the River Severn and River Thames additional sources of water have been identified to augment the natural flows and ensure that a transfer can be maintained. These sources and their conveyance through the rivers, in addition to the STT SRO comprise the STT System and are detailed below illustrated geographically in Figure 3-1:

STT Sources

- **Lake Vyrnwy**: Utilisation of up to 180Ml/d of water licensed to United Utilities from Lake Vyrnwy (facilitated by North West transfer SRO) by two separate means:
  - a direct release of 25Ml/d of water into the head of the River Vyrnwy.
  - a release of 155Ml/d of water into the existing Vyrnwy Aqueduct/ Oswestry
- **Mythe**: Temporary transfer of 15Ml/d of Severn Trent Water -licensed abstraction at Mythe, thus releasing flows to the River Severn.
- **Minworth**: The transfer of 115Ml/d of a highly treated wastewater discharge from Severn Trent Water's Minworth WwTW to the River Severn via the River Avon; and
- **Netheridge**: The transfer of 35Ml/d of a highly treated wastewater discharge at Severn Trent Water's Netheridge WwTW to a new location upstream of the current discharge to the River Severn. To ensure flows are provided to the Interconnector for all river conditions, Netheridge has been identified as the source for the 20Ml/d sweetening flow when unsupported flows are unavailable.

3.2 During the Gate 2 process, information was provided to the WRSE to assist them in their analysis. This was the most accurate information available at that time. A comparison of the information applicable to Gate 1, WRSE data provision and current Gate 2 proposal is indicated in Table 3-1. It should be noted that the proposals for Gate 2 have developed since the provision of data to WRSE but the changes will be aligned with the regional plans and WRMP's in 2023. This will allow WRSE to include the up to date data in the finalisation of their Regional Plan.

Table 3-1 Source capacity changes since Gate 1

Source	Gate 1 proposal Capacity	Gate 2 v. Gate 1 proposal	Comments
River Severn water i.e. unsupported	Up to the interconnector capacity i.e. 300Ml/d (pipeline and canal option), 400Ml/d pipeline and 500Ml/d pipeline	500Ml/d capacity preferred	Recommendation from WRSE draft plan
Minworth	115Ml/d	115Ml/d (2 phase release)	Phased to allow more flexibility and adaptability
Mythe	15Ml/d	15Ml/d	Required to resolve WRW deficit in draft plan
Netheridge	35Ml/d	20Ml/d for interconnector sweetening flow	Sweetening flow required when unsupported flow unavailable
Shrewsbury	25Ml/d	25Ml/d	Required to resolve WRW deficit in draft plan
Vyrnwy	155Ml/d (5 phase release)	180Ml/d (6 phase release)	Increase in trade volume because of North West Transfer

3.3 Collectively, the Interconnector, River Vyrnwy bypass pipeline, Shrewsbury Redeployment, the source SROs, and conveyance of the source support elements through the river systems (Vyrnwy, Severn, Avon, and Thames) form the elements of the STT system.

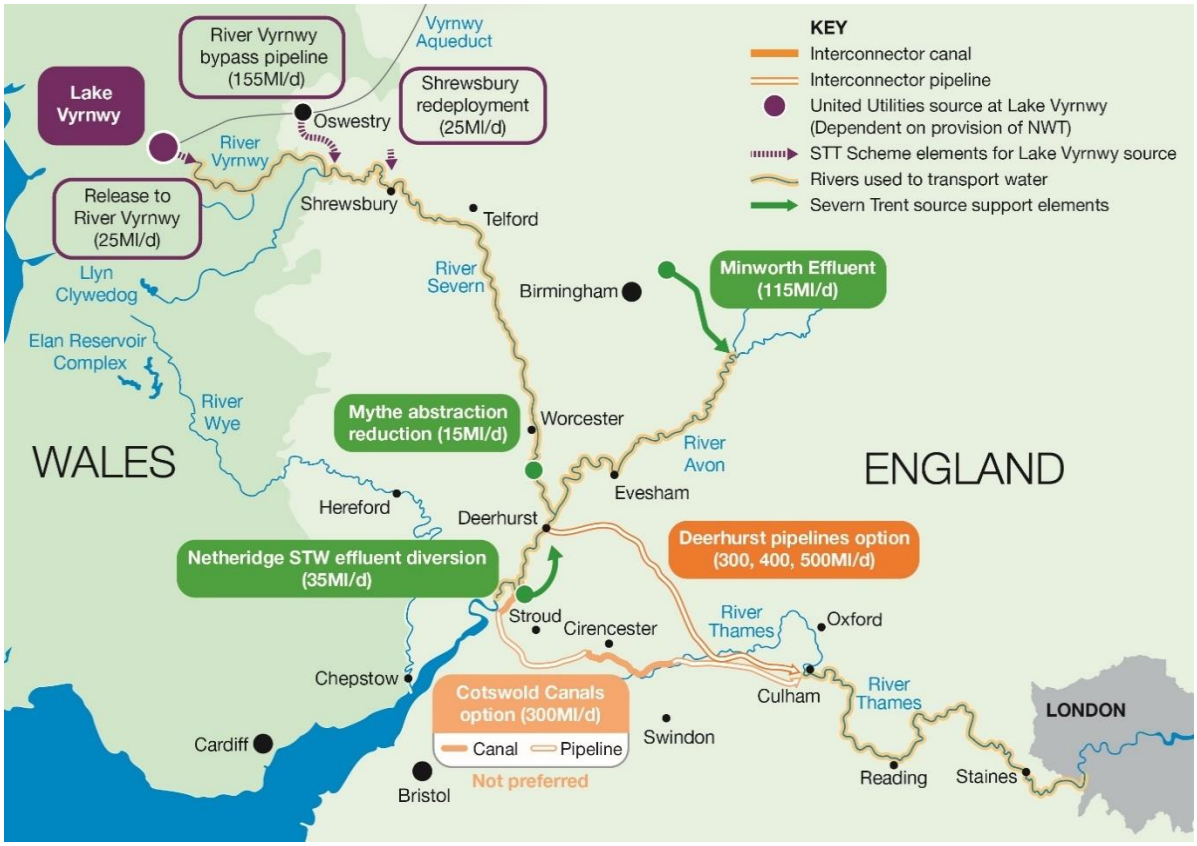


Figure 3-1 STT system overview

3.4 The Interconnector will transfer treated river water (unsupported flow) from the River Severn to the River Thames when there is a need. When the flow in the River Severn is insufficient or is below the Hands off Flow (HoF), then source discharges and Interconnector abstraction in line with the proposed permitting road map will operate. The permitting road map (see Chapter 7) will deal with the entire system to ensure the full implications of the discharges and abstractions are considered. This STT Gate 2 submission relates to all aspects of the Interconnector options, including treatment, mitigation works, the unsupported element and the overall STT system's operation.

3.5 To ensure efficient and effective operation of the Interconnector and to avoid stagnation of the water, a minimum or "sweetening" flow is always required. As the unsupported flow is not always guaranteed, the Netheridge support flow has been selected as the sweetening flow source. Source inputs will be varied according to need and in accordance with Best Value.

3.6 The losses within the system were assessed for each part of the river system in Gate 2. These have been reduced from the 20% used in Gate 1 to 15% for the River Severn and remain at 10% for the River Avon. It is noted that the losses in the Thames are 2%. This is discussed further in Chapter 4.

3.7 The changes in the STT SRO and system proposal from Gate 1 are tabulated in Table 3-2. It is noted that there are no works proposed in Wales and that there is no change in water demand from that currently abstracted by United Utilities. The release proposed into the River Vyrnwy has been reduced to avoid impacts on the environment while still allowing sufficient headroom for the required compensation releases as stipulated by the Liverpool Corporation Act 1880 which authorises the discharge of compensation water from the Vyrnwy Reservoir into the River Vyrnwy (1880 Act).

3.8 There are several configurations for how the Interconnector source elements could combine. The source elements can be introduced in a phased manner in response to an increasing deficit. To further enhance adaptability, the Vyrnwy and Minworth sources can be broken down into six phases and two phases, respectively. This reflects the work required to release their respective flows but also highlights the adaptability of the sources to meet varying needs.

3.9 Optimisation modelling has revealed the optimum phasing of the sources. This indicates how the sources will be brought into operation sequentially to provide the required flows. When not required, the

sources will be taken out of operation and will either be drained down or operated at a minimum sweetening flow.

3.10 The need for the transfer of water will be determined by monitoring the Lower Thames reservoir levels, the River Thames water levels, and the prevailing and forecast weather. Should this indicate the need for a transfer the river levels in the Severn will be assessed to establish if unsupported flows can meet the required demand and the interconnector treatment will be ramped up in capacity to provide the required flows. Should the river flows not meet the flow requirement (e.g., below HoF) then the source operators (UU and STW) will mobilise and start to ramp up the various assets required to bring the sources on-line. A notice period of 20 days will be required to bring the interconnector and source support online.

Table 3-2 Changes in the proposed elements of the STT system since Gate 1

Element	Gate 1 proposal July 2021	WRSE data (February 2022) v. Gate 1 proposal	Gate 2 proposal v. WRSE data
Support (general)	Principle of "put and take" in place	unchanged	Permitting strategy developed with regulators
Interconnector	Deerhurst Pipeline and Cotswold Canals proposals deemed feasible	unchanged	Deerhurst Pipeline now preferred at 500Ml/d capacity
Vyrnwy Release	Release of 75Ml/d from the reservoir and 80Ml/d bypass to the lower River Vyrnwy.	Release of 75Ml/d from the reservoir and 105Ml/d bypass to the lower River Vyrnwy.	Release of 25Ml/d from the reservoir and 155Ml/d bypass to the River Severn.
Shrewsbury	Reduction in abstraction at Shelton to provide 25Ml/d to STT	unchanged	unchanged
Mythe	Reduction in abstraction at Mythe to provide 15Ml/d to STT	unchanged	unchanged
Minworth	Diversion of effluent discharge from the River Trent to the River Avon to provide 115Ml/d to STT	unchanged	unchanged
Netheridge	Diversion of effluent further upstream to provide 35Ml/d to STT	20Ml/d to be provided as sweetening flow	20Ml/d to be provided as sweetening flow
River Losses	20% assumed for the River Severn and 10% for the River Avon	15% assumed for the River Severn and 10% for the River Avon	15% assumed for the River Severn and 10% for the River Avon

3.11 The phasing proposal submitted to WRSE for inclusion in their regional modelling is discussed in more detail in Chapter 4. This information, along with costs, environmental metrics, and resilience metrics, has been provided to the WRSE. The WRSE have modelled the variety of SROs and Water Resource Management Plan (WRMP) proposals.

3.12 The WRSE draft regional plan has indicated that the 500Ml/d option for STT SRO is required by 2050 utilising the Netheridge sweetening flow and unsupported flows. The support elements of the STT come online in a phased manner thereafter. However, it is noted that in the draft regional plan the Shrewsbury and Mythe sources are required to service a deficit in the WRW region. Therefore, they are not currently available to WRSE. This position will be reviewed in Gate 3 when the regional plans are finalised following their consultations.

3.13 In Gate 2, work has been carried out to develop the SRO proposal and is detailed below:

Interconnector

3.14 The various options for an Interconnector to treat and transfer water from the River Severn to the River Thames have been appraised to determine whether the Deerhurst Pipeline option or Cotswold Canals option represent best value.

3.15 An options appraisal study was conducted which sought to identify and assess alternative interconnector solutions, encompassing a wide range of options, progressing from the "viable" option at Gate 1 to a preferred solution for the purposes of Gate 2.

3.16 The option appraisal methodology had three stages: Longlist, Shortlist and Validation. The Longlist and Shortlist stages focussed on a 300 Ml/d capacity transfer for water supply, whereas the Validation stage considered a range of potential futures, including larger capacity transfers and integration of the water supply scheme with restoration of the disused Cotswold Canals for boat navigation. Longlist appraisal was undertaken against qualitative environmental impact and engineering criteria for a variety of transfer options as indicated in Figure 3-2. Shortlist appraisal and Validation considered costs and multi-sector benefits, in a quantitative (monetised) and qualitative assessment. The multi-benefits analysed in the Shortlisting and Validation covered social values (e.g., wellbeing) and amenity values (e.g., fishing, boating) to ensure a holistic review was conducted.

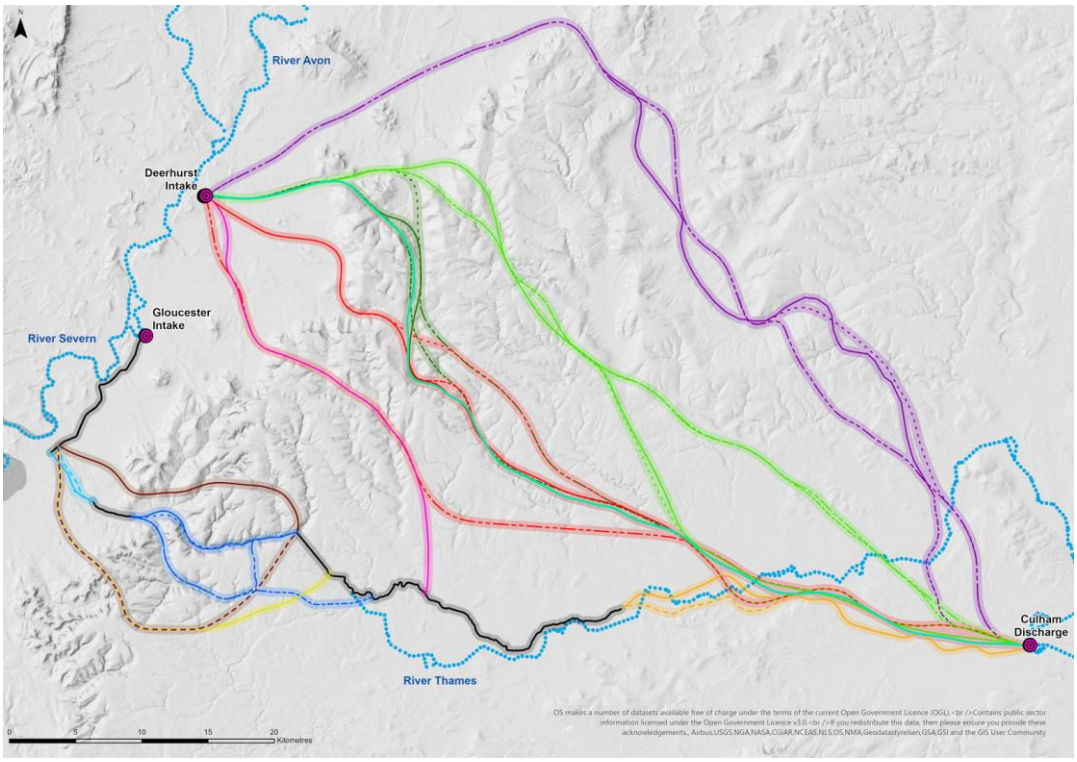


Figure 3-2 Interconnector options considered in the Longlist appraisal

3.17 The appraisal selected a preferred Interconnector option that would transfer water from the River Severn to the River Thames through the Deerhurst Pipeline. A schematic of the preferred option is included in Figure 3-3.

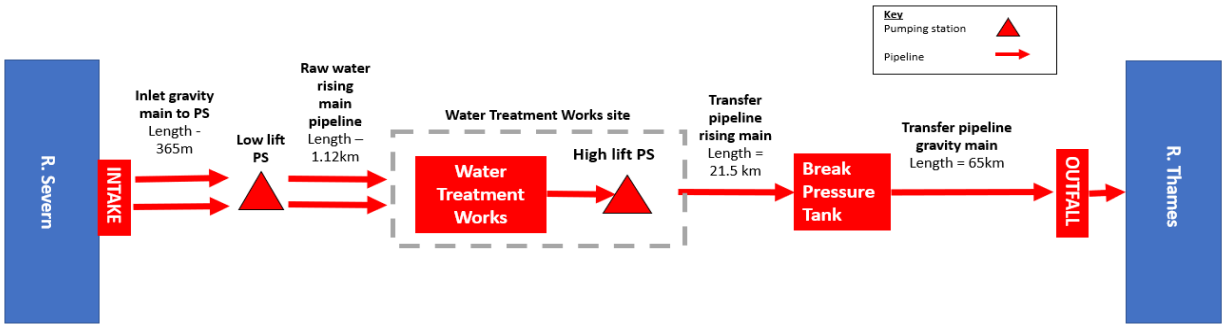


Figure 3-3 schematic of preferred option

3.18 The study recognised that options that utilised reconstructed sections of the Cotswold Canals would provide opportunities for enhancement of tourism and recreation. However, it was concluded that selecting a canal-based option for water transfer would not provide good value, with a direct pipeline option:

- performing better overall against a range of environmental and resilience criteria

- having the lowest Net Present Cost (including monetised social, natural capital and carbon impacts and benefits), being approximately 25% cheaper than other options
- meeting the WRSE regional plan selection of a 500Ml/d capacity transfer (options incorporating sections of canal would be limited to 300Ml/d maximum capacity)

3.19 Whilst this reflects the findings for Gate 2, before any final decisions are made and as part of any future phases of the STT development, the preferred option and other alternatives considered would be subject to further engagement and consultation with stakeholders.

River Vyrnwy Bypass Pipeline

3.20 An options appraisal study was conducted which sought to identify and assess alternative bypass options, reviewing and refining the initial seven options assessed at Gate 1 to a preferred solution for Gate 2. The routes examined are indicated in Figure 3-4 and the assessment is annexed to this report.

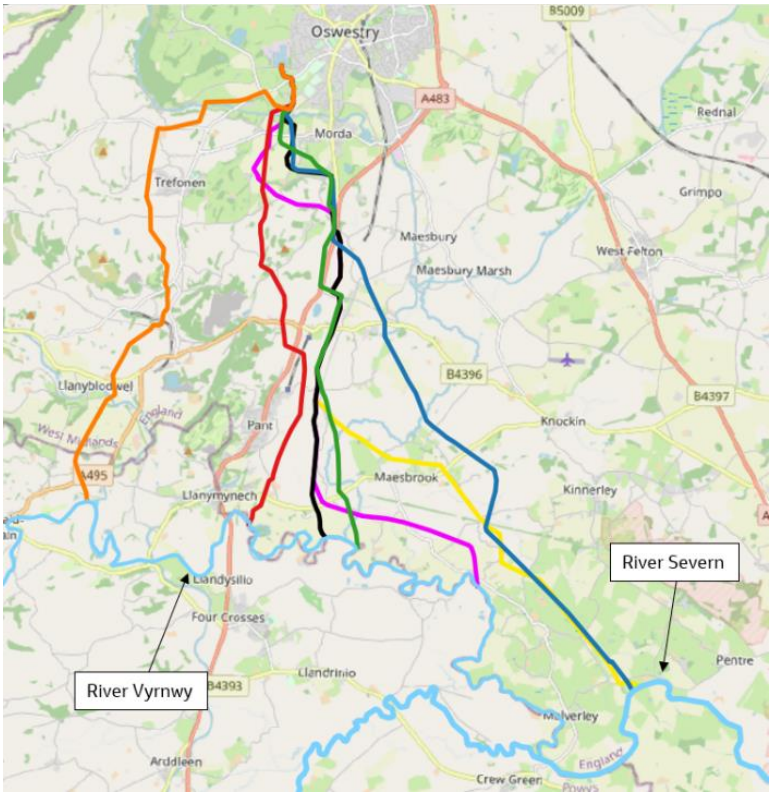


Figure 3-4 Options reviewed for the Vyrnwy Bypass Pipeline

3.21 The assessment focussed on 105Ml/d, 180Ml/d, and 205Ml/d bypass capacities with discharges to the Lower Vyrnwy and to the River Severn. Preferred route options for a gravity discharge to the Lower Vyrnwy and to the Severn were selected with the final recommendation of a discharge to the Severn determined by environmental considerations. It has been concluded that a discharge to the River Severn is required to protect environmental designations in the River Vyrnwy while still allowing sufficient headroom for the required compensation releases as stipulated by the 1880 Act (refer to Chapter 6).

Shrewsbury Redeployment

3.22 The Shrewsbury Redeployment has been reviewed and refined during Gate 2. While refinements have been made to the proposal the principle of a 25Ml/d reduction in the abstraction from the River Severn at Shelton remains unchanged.

Source SRO's

3.23 The interconnector, bypass, and Shrewsbury elements of the system have no resource benefit. Resource benefit comes from the natural flow in the River Severn (unsupported flow) and the related source SROs providing supported flow. The source SROs are:

- North West Transfer;

- Minworth; and
- Severn Trent Sources (this covers both Netheridge and Mythe).

3.24 The concept designs for each of the source elements are described in their own Gate 2 submissions.

4 Water resource assessment

Introduction

4.1 For Gate 2 work has progressed to update the assessment of water resources benefit from STT including consideration of potential conjunctive use benefit. Quantification of the anticipated operational utilisation has also been undertaken including consideration of how multiple users may call on and benefit from STT.

4.2 Work progressed for Gate 2 has fed into the WRSE modelling for firstly the emerging plan and now the draft regional plan. Work which has not been completed in time for inclusion in WRSE modelling so far will be incorporated in the update window in 2023 and reflected in the Gate 3 submission.

4.3 A number of models, as detailed in Table 4-1, have been used to understand the Deployable Output (DO) benefit of STT. They were also used to understand its utilisation, the pre-optimisation of its source options and its interaction with the United Utilities and Severn Trent Water systems, and River Severn Regulation.

Table 4-1. Models used to calculate the DO benefit and utilisation and characterise other aspects of the STT SRO

Model	Purpose	Description
Kestrel rainfall / runoff modelling	Rainfall / runoff to derive River Severn flows	To derive the River Severn flows based on stochastic climate data and informed by River Severn Regulation, abstractions and returns. These flows inform what unsupported flow is available based on Hands Off Flow rules at Deerhurst.
WRSE Pywr simulation model	Deployable Output calculation	To calculate the DO benefit of the STT SRO based on the need from London. The DO benefit is defined in terms of unsupported river flow and support options.
STT Pre-Optimisation Model	STT support option sequencing	To understand the optimum sequence of support option implementation
WRSE Investment Model	Selection of regional schemes	Completed by the WRSE, to identify time steps that different components of the SRO are selected and utilised.
STT/SESRO/T2ST Pywr model	Deployable Output calculation	To understand the conjunctive benefit of STT.
STT Pywr system model	Exploration of operational considerations	Developed by STT to better model shared aspects of UU and STW systems (e.g. Lake Vyrnwy and River Severn Regulation).
STW Aquator model	Inputs and calibration	Outputs from the model used as inputs into WRSE Pywr model and calibration with STT Pywr system model. Assessment of the impact on the UU system based on STT utilisation.
UU Aquator and Pywr models	Inputs and calibration	Outputs from the model used as inputs into WRSE Pywr model and calibration with STT Pywr system model. Assessment of the impact on the UU system based on STT utilisation.

4.4 Whilst there was no modelling related to the estimation of losses in the STT system, additional physical tests and analysis was completed to better understand them. The output of losses investigations is reflected in the modelling listed above.

Water resource benefit

4.5 The DO benefit was calculated with the same methods used for WRSE DO modelling and a thorough investigation and comparison of changes and differences from WRMP19 modelling was completed. The DO benefit is calculated by incrementally increasing the demand in the London Water Resource Zone and testing the ability of existing supplies in London with support from STT to meet this demand without the requirement of an Emergency Drought Order (EDO). This modelling quantifies the maximum amount of water required from STT to help the London zone meet an increasing level of demand.

4.6 The DO summarised in Table 4-2 was calculated based on the system response that would initiate an EDO (as per EA WRPG) during a simulated 1:500 drought. The system response that would require an EDO is based on the control curves that drive water security for the London Water Resource Zone. As the London Water Resource Zone has plentiful reservoir storage, there is no need to calculate peak DO values for unsupported flow. STT support options are represented in a modular fashion and the incremental flow represents the amount of water released for each modular step. One assumption in the WRSE Investment Model (IVM) is that only the London zone can benefit from unsupported flow, due to its reservoir storage. The other companies that could benefit from unsupported flow (Affinity, Southern and South East) do not currently have adequate storage to store and utilise the unsupported River Severn flows. Therefore, until another reservoir is identified that can provide capacity, these companies cannot benefit from unsupported flows. To address this issue, the WRSE model requires a reservoir to be built in the upper Thames before any other company besides Thames Water (TW) can benefit from unsupported flow. A reservoir in the upper Thames provides storage upstream of the Affinity Water abstraction and at a location beneficial to the Thames to Southern transfer. However, these companies can benefit from the use of support options on average and at peak periods because the benefit from support options can be provided at any time of the year.

Table 4-2. Summary of STT maximum capacity and average and peak DO potential

Source element sequence	Element	Max flow (Ml/d)	Incremental flow (Ml/d)	Loss before Deerhurst (%)	Max flow at Deerhurst (Ml/d)	Average DO at WRSE (Ml/d)	Peak DO* at WRSE (Ml/d)
1	Netheridge	35	35	0	35	24	34
2	Unsupported flow – 500Ml/d pipe	500	500	0	n/a	134	134
3	Vyrnwy Release	50	50	15	43	29	41
4	Vyrnwy Release	75	25	15	21	14	20
5	Vyrnwy Release	100	25	15	21	14	20
6	Vyrnwy Release	135	35	15	30	20	29
7	Vyrnwy Release	155	20	15	17	9	12
8	Vyrnwy Release	180	25	15	21	17	24
9	Minworth	58	58	10	52	35	50
10	Minworth	115	57	10	51	35	49
11	Mythe	15	15	0	15	10	14
12	Shrewsbury Redeployment	25	25	15	21	14	19
Max unsupported flow at Deerhurst					500	134	134
Max support options at Deerhurst					328	221	313
Total DO received in the south east						354	447

*Peak DO at WRSE accounts for assumed losses in the interconnector at 2% and losses in the River Thames at 2%.

4.7 United Utilities promotes a maximum of 180Ml/d to STT from Lake Vyrnwy as a sustainable yield of water that can be provided based on their current use patterns and infrastructure.

4.8 Severn Trent Water promotes a maximum of 35Ml/d from Netheridge and 115Ml/d from Minworth as sustainable amounts that can be delivered to STT. Modelling has been initiated to assess any impact on the River Tame and River Trent relating to Minworth providing DO benefit to both Grand Union Canal (GUC) and STT. This will be reported in the Minworth SRO Gate 2 report.

4.9 Regional modelling is ongoing. Gate 2 is based on best current estimates of water needed in the west and south east. Utilisation of sources over time is being considered and will be further explored for Gate 3.

4.10 Additional STT/SESRO/T2ST Pywr simulation modelling has been completed outside the WRSE IVM to assess any benefit of linking STT (with a 500 Ml/d pipe and 328 Ml/d of support) to SESRO via a connection pipe. This modelling was commissioned to also understand the impact of providing water to the T2ST at the same time.

Without the T2ST connections, the modelling results show:

- Linking SESRO and STT provides additional base DO of 7.6Ml/d (1.2%). Linking the SROs means that STT water can be used to refill SESRO during the rare periods when the London support is not activated
- Climate change has a greater (but minor) negative impact when the SROs are separate rather than linked, just 3.2Ml/d at the 1:500 return period.
- Therefore, the combined DO benefit of linking SESRO and STT is 11Ml/d when median climate change impacts are included on top of the base DO benefit.

With the T2ST connections, the STT SESRO link provides:

- The option combination that results in the highest conjunctive use benefit and hence the most efficient system is the combination of the STT, SESRO and T2ST. If SESRO and STT are combined, then this could result in a net benefit of 19 Ml/d if combined with the T2ST, compared to separate operation.

This additional work shows that there are some conjunctive benefits from connecting STT with SESRO. This is limited due to the fact that for most of the time the flow in the River Thames during winter is enough to fill SESRO and therefore there is less need for additional water from STT. These conjunctive benefits are not yet part of the WRSE IVM and will be included in the next set of updates.

4.11 Detailed river flow modelling has been initiated to understand the appropriateness of the WRSE 600 Ml/d IVM limit on water to be transferred to London via the Thames. The results of this modelling will inform the next phase of WRSE modelling.

Comparison of DO based on data sets

4.12 The DO Benefit was calculated by simulation using the same methods and Pywr models as the WRSE used for the baseline DO for each Water Resource Zone in the south east. River Severn flow series were developed using the HRW Wallingford Kestrel model.

4.13 A thorough review and comparison was completed to understand any difference in River Severn flows using WRSE stochastics and WRW stochastics with the HR Wallingford Kestrel model as well as River Severn flows generated by the Severn Trent Water Aquator model. A slightly increased DO with WRW stochastics and flows generated by the Severn Trent Water Aquator model compared to the WRSE stochastics occurs because WRW stochastics are influenced by the wetter north-west areas and the WRSE stochastics by the drier south-east.

4.14 A final comparison of DO derived with new and old stochastics was completed to understand if there is any material difference. The old stochastics show a reduction in DO benefit for the STT SRO because these older stochastics result in larger flows during more extreme events. Therefore, the drought impacts tend to be less extreme and there is less need for the STT SRO.

4.15 Therefore, considering all of the above, the new version of the WRSE stochastics dataset offers a better starting point to develop the STT DO assessment. This ensures that the modelling benefits from more accurate base data sources (i.e., precipitation and temperature data from 1950 onwards is more trustworthy) and to ensure spatial coherence and comparability with other strategic options that are available in the south-east region (i.e. the use of WRSE stochastics instead of WRW stochastics ensures the DO from the River Severn is assessed with a spatially compatible set of data as is used in the south east).

Utilisation

4.16 The amount of water that STT can provide has been quantified with current Deployable Output modelling defined in the Water Resources Planning Guidelines. The result of DO modelling provides a utilisation time series that identifies at what point in time the STT SRO is needed, for how long and the magnitude of water required. The utilisation time series also clarifies the amount of water derived from unsupported River Severn flow and what additional support would be required from the support options provided by United Utilities and Severn Trent Water. These utilisation time series help United Utilities

and Severn Trent Water assess any impact on their water resource systems from providing the water for the support options.

4.17 The original source of this utilisation time series is based on DO modelling completed with the Thames Water Aquator model using historic river flow values. We advanced this assessment of utilisation by using results from stochastic DO modelling completed with the up to date WRSE Pywr model. Table 4-3 provides a summary of frequency, duration and magnitude of STT utilisation based on historic and stochastic DO modelling. On any day, the water conveyed by the STT Interconnector could be either all unsupported flow, only support options or a combination of the two. There is a similar pattern of overall utilisation of the unsupported transfer and the support options for the historically derived and stochastically derived utilisation patterns.

Table 4-3. Summary of utilisation over historic and stochastic time series of River Severn Flow

Aspect	Based on historical flow data (1920 – 2010)	Based on stochastically generated flow data (climate drivers from 1950 – 97)
Overall utilisation throughout the complete time series – unsupported transfer	6.20%	7.80%
Overall utilisation throughout the complete time series – all types of support	22.30%	22.60%
Period of support in key droughts Note: the realisation number represents one version of the stochastic sequence	Top 5 historical	1 in 500-year droughts (as highlighted by WRSE)
	244 days (1944)	230 days (realisation 66, 1976)
	234 days (1921-22)	232 days (realisation 152, 1976)
	226 days (1976)	194 days (realisation 209, 1992)
	214 days (1990-91)	209 days (realisation 302, 1976)
	197 days (1945)	189 days (realisation 348, 1992)

4.18 United Utilities and Severn Trent Water were provided utilisation time series for support option utilisation so each company could understand any impacts on their company water resources models. Both companies stated that they can support the STT at the full capacity of their support options based on the utilisation profiles.

Losses

4.0 Losses are applied to support options if there is a long distance of travel to represent the amount of water lost to groundwater on route to the abstraction point at Deerhurst. There have been a number of pieces of work undertaken to understand what losses might be. For the River Severn these include a physical release, a statistical analysis of historic releases, analysis of the ungauged catchments and correlation analysis. For the River Thames and River Avon a study of net yield was completed.

4.1 A technical assessment was completed to characterise losses to Lake Vyrnwy support water. This assessment was based on the physical release of different amounts of water and tracking the resulting flows at different gauges downstream. It was found that if larger amounts of water were released for longer periods of time, the percentage of loss diminished. However, the relationship of duration and time was very tenuous. In addition to this physical test a statistical analysis of historic releases and their associated losses was completed to better understand losses from a historical perspective.

4.2 The studies done so far have provided a basis for the losses assumptions at Gate 2 but there remains large uncertainty associated with these.

4.3 For Gate 2, based on the results of the physical release the understanding of how losses affect the Vyrnwy support option was improved and as a result this was reduced from 20% at Gate 1 to 15%. However, with the reduction in direct release volume, the location of the discharge from the bypass now being into the River Severn and any learning from the dry summer of 2022 there is a need to review this again. The SRO changes and impacts of summer 2022 were too late to be able to accommodate a change in losses assumption in modelling for Gate 2.

4.4 An additional study is planned to consider all of the work done so far and changes to the STT SRO design and learning from the dry summer 2022 with a view to revise the losses assumptions for Gate 3. This study will be completed in time for the WRSE update in 2023.

4.5 For Gate 2, losses are assumed to be 2% for the River Thames. This is based on the lower estimate of losses (range of 2-10%) from on a study of net yield. In comparison, for the Avon the upper estimate of 10% was adopted. The more precautionary approach for the River Avon was taken based on potential impact on the Severn estuary SAC and a larger stage difference. These loss assumptions will also be investigated and reviewed for Gate 3.

Operating scenarios

4.6 An assessment of the utilisation of STT water based on historical time series highlighted short gaps of less than 3 days when support is not utilised and also calls for support durations of less than 3 days. We removed these gaps in support and short lengths of utilisation to create an adjusted operating pattern that would be more reflective of actual operating regimes. After these gaps in utilisation and shorter durations of utilisation had been removed, an operational assumption was made that any remaining utilisation should be at least 20 days in duration. This assumption has been carried forward to the STT operating strategy and will also be carried forward to inform more detailed assessment of STT operations within the STT Pywr system model for Gate 3.

4.7 The STT Pywr system model has been used to better represent shared components of the system and to understand the resilience of the STT. For Gate 3, different operational regimes and the associated environmental impact will be explored. The model was not developed to an extent to allow this during Gate 2. The STT Pywr model is discussed further below.

Multiple users

4.8 Multiple users of the STT have been identified by the WRSE Investment Model (IVM): Thames Water and Affinity by abstraction from the River Thames and via the T2AT; and Southern Water and South East Water via the T2ST. The final output from the regional modelling is needed to better define and quantify how much each company could benefit from STT. The prioritisation and commercial models will be developed in Gate 3 once the final regional and company WRMPs are adopted.

4.9 The conjunctive benefit of STT and SESRO to satisfy the needs of Thames Water and Southern Water has been explored. For Gate 3, further conjunctive benefit related to the T2ST will be assessed.

4.10 For Gate 3 the conjunctive benefit of STT modelled alongside the implementation of other options selected by the WRSE IVM for Thames Water, Affinity Water and Southern Water will also be explored. These explorations could analyse the conjunctive nature at different future time steps and under different future supply/demand scenarios.

4.11 Utilisation of some of the Vyrnwy support option by Severn Trent Water (within WRW) has been identified as a potential need. This utilisation by Severn Trent Water may be short term and then the water can again be available for transfer to the WRSE. There has been no identified need for Lake Vyrnwy water for South Staffs Water as local solutions address their deficit. Nor has there been an identified need for STT to transfer water to Water Resources West Country (i.e., to South West Water or Bristol Water). While the core scenario from regional planning identifies the use of STT as a transfer to WRSE, the opportunity to transfer to other regions remains a possibility should future needs arise.

STT System Model

4.12 A STT Pywr system model was developed to better understand the joint use of Lake Vyrnwy and the impact of river regulation under the 1880 Act on the STT SRO. This system model includes representations of the United Utilities and Severn Trent Water, water resources systems which are both very close replicas of each company's Aquator model. The system model also includes representation of use of the River Severn for River Severn river regulation.

4.13 This STT Pywr system model has been developed with review from all the STT partners. Detailed validation and calibration workshops have been held with United Utilities and Severn Trent Water to ensure their systems are represented properly. This joined-up modelling allows for a better understanding of the STT system behaviour, and it facilitates an exploration of STT resilience to drought events, up-to-date demand forecasts and environmental and operational constrictions. We have presented the system model to regulators and there is future opportunity to help with their work, e.g., refining River Severn regulation rules. When WRSE outputs from the regional planning process are finalised, consideration will be given to how the use of STT can be optimised within the context of needs

from Severn Trent Water and water companies in the south east. This will also be considered in conjunction with other options that are selected at different time steps in the future.

Scalability and optimisation

4.14 The STT system comprises a number of resource options which can be developed in a modular way. The optimal order to develop the source inputs has been updated since the first iteration for Gate 1, to simplify the approach.

4.15 The optimum ordering of STT resource options was explored using a genetic algorithm. This was configured to determine the least cost solution over an 80-year analysis period to meet a defined deficit profile. The environmental and resilience metrics for the solutions are reported as an output but are not part of the optimisation. The optimisation modelling alongside the review of environmental and resilience metrics considers the best value optimisation of the source inputs. Inputs to the model have been updated to reflect development in the design of the STT option. Updated scenarios have been explored to understand the sensitivity of costs, environmental and resilience metrics to different ordering of the implementation of STT resource options.

4.16 The optimisation demonstrates that cost is not a differentiator (the range in cost of different scenarios was not significant), nor are environmental and resilience metrics a reason to select a different order for the STT resource options. The practical factors for delivery order of the sources are a differentiator. It makes practical sense to utilise a source to its full capacity before another source is brought online. For example, Lake Vyrnwy is most often selected as the second support option (after Netheridge) and it makes more sense to fully utilise this asset before constructing Minworth. The practical ordering was considered outside of the optimisation model and the results of different orderings showed no material difference. The preferred order for the STT elements is shown in Table 4-4.

Table 4-4. Preferred order

Phase	STT element
1	Netheridge
2	Unsupported
3	Vyrnwy step 1
4	Vyrnwy step 2
5	Vyrnwy step 3
6	Vyrnwy step 4
7	Vyrnwy step 5
8	Vyrnwy step 6
9	Minworth phase 1
10	Minworth phase 2
11	Mythe
12	Shrewsbury

Option resilience

4.17 Resilience metrics have been designed by WRSE and scores applied for each of the source elements of STT by WRSE to ensure consistency of application across all SROs. Additional resilience metrics are calculated by the WRSE based on the portfolio of options selected for the region. Option-specific resilience metrics have been derived based on assessments under the following three indices:

- Reliability: Reflects resilience to transient shocks and stresses
  - Uncertainty of option supply/demand benefit
  - Vulnerability to physical hazards
  - Catchment/raw water quality risks (incl. climate change)
  - Risk of failure due to exceptional shocks
- Evolvability: Reflects the ability to respond to unplanned, longer-term, or chronic stresses
  - modularity and scalability
  - reliance on external bodies
- Adaptability: Reflects resilience to transient shocks and stresses
  - Operational complexity

4.18 For STT the resilience scores are largely mid-range (scoring 3 or 2 on a range of 1 to 5 where 1 indicates lower resilience) and are consistent across the support options. STTs lowest score (1) has been assigned to all the support options for reliance on external bodies. WRSE assigned this score based on the view that the SRO relies on EA and NRW agreement on permitting. Significant progress on this has been made in Gate 2 but there has not been an opportunity to update the score. The unsupported

flow scores low (1) for uncertainty of option supply (high uncertainty) as there was uncertainty (at the time of the WRSE model run – Feb 2022) that there will be unsupported flow available when required. All elements of STT have been scored 2 for modularity by WRSE based on their definition of scalability ('likely to require investment in significant fixed infrastructure').

4.19 The option-specific resilience metrics and the scores are unchanged from Gate 1. There will be opportunity to review the scores for the 2023 WRSE modelling update.

Operational supply resilience

4.20 The STT system is modular and has multiple source inputs providing resilience in the event of operational failure of one of the support elements. It does not provide standby for the full capacity, but partial transfer can be maintained if one element fails, notwithstanding the notice period to bring an alternative element online if not already being deployed. There may also be the potential to extend utilisation by adding storage in the system to give some element of standby.

4.21 It is noted that the interconnector proposed is a single pipeline. This does not impact on its resilience given the low utilisation predicted for the SRO. Therefore, any maintenance required to the SRO can be completed when the transfer is not in operation.

4.22 The United Utilities North West Transfer SRO backfill options which enable the availability of support water from Lake Vyrnwy are spread over a wide area and as a result these are considered to be resilient to drought.

4.23 The STT system requires a minimum notice period of 20 days for the transfer to become fully operational. This is driven by the period required to bring the treatment works at the Interconnector and source supports online. Therefore, the SRO will not be available to provide resilience in the event of an emergency or an operational failure which requires immediate support. However, there is the potential to utilise the SRO to facilitate planned maintenance of other significant infrastructure or where an emergency requires longer-term support. STT could be used to quickly replenish depleted reserves utilised in an emergency. At Gate 3 the opportunity to review the ability to ramp up the treatment works at the interconnector and bring support elements online quicker will be explored.

Climate change adaptation

4.24 The DO for the unsupported element accounts for climate change impacts (median RCP 8.5) and therefore it is considered to be resilient to climate change. The availability of the Vyrnwy supported option has also been tested for climate change using RCP 6.0 with sensitivity testing. The Minworth and Netheridge options are not impacted by climate change due to the nature of the sources. Droughts in the Severn catchment and the Thames catchment will not always be coincident and therefore there is some resilience against droughts through this option.

Resilience of the natural environment

4.25 Discussions regarding permitting of the SRO are ongoing. Opportunities to bring environmental benefits/improve resilience of the environment through interaction with the operation of River Severn Regulation releases (to assist with variable flows) will be explored as discussions progress. The STT partners have committed to >10% BNG for this SRO and opportunities for this will continue to be explored and developed.

4.26 Sections of river between the point of support entering and exiting the river will benefit from augmented flows during operation i.e., there will be more water in the river than there would be without STT and this may support the ecology at times of low flows.

Enabling capacity increases in future

4.27 The solution forms the spine of a transfer of resource from the north of England to the South of England. The STT system has the ability to transfer water to multiple regions. The transfer is currently proposed for WRSE via the Interconnector but transfer to Water Resources West Country and WRW can also be facilitated without the Interconnector. There is the opportunity to expand the current solution to incorporate other support sources in future to provide even greater resilience. RAPID published a gap analysis report entitled "Meeting regional and national water resource needs: gap analysis of the current strategic infrastructure scheme portfolio" (August 2020). This highlighted additional support elements that could be advanced which could utilise the STT to provide water to the South East of England, if

needed. One of these options (Kielder Reservoir) is currently being reviewed for potential to be promoted as an SRO providing support to STT. The current proposals for overall deployable benefit of the STT highlight that additional support sources could be added in the future. This would ensure that full capacity can be provided independently by both unsupported and supported sources, if required. There is also the potential to improve connectivity in WRSE to better distribute STT water in the future.

Infrastructure resilience to the risk of coastal erosion

4.28 The STT system does not impact on coastal erosion. It is an inland transfer scheme. The solution makes use of unsupported flow to the Severn Estuary when operated above the HoF in the River Severn and transfers it to the River Thames. It therefore marginally reduces the flow to the Severn Estuary. Additional supported flows will only be put into the River Severn at times when the transfer is required and river levels are below the HoF. The system will operate under a 'put and take' arrangement and therefore additional flow will not flow to the estuary.

Infrastructure resilience to the risk of flooding

4.29 The STT does not increase the risk of flooding. An assessment of potential flood risks has guided the initial site selection options for the Interconnector and associated pumping station and treatment works. Infrastructure is sited outside the floodplain as much as possible: the intake is within the floodplain but all electrical equipment will be above the floodplain.

4.30 The STT support elements will largely operate at times when the flow in the River Severn is below the HoF or when there is insufficient unsupported flow above the HoF to fill the Interconnector capacity. As such, STT supported elements will not be operated at times of flood and will not increase flood risk in the catchment. In the event that heavy rainfall occurs whilst support elements are operational and there is deemed to be an enhanced risk of flooding, these will be switched off. The operational rules around this will be determined as part of the ongoing development of the solution and will likely form part of a Section 20 agreement under the Water Resources Act 1991 with the EA as part of the permitting of the SRO.

4.31 The STT does not include any storage within the SRO: it is a transfer of water from one catchment to another. As such, there is no opportunity to store flood water within the solution.

4.32 There is the potential to transfer water from the River Severn to the River Thames if the River Severn is in flood but the size of the transfer will be limited to the capacity of the Interconnector. The capacity of the Interconnector is relatively small compared to the scale of the potential spate flows. Transfer under these circumstances would only be possible if the River Thames were not in flood at the same time as the River Severn. The benefit of such a transfer is questionable given the limited impact on flows.

4.33 During Gate 2, discussions have been held with the River Severn Partnership – Shropshire Flood Prevention to explore opportunities to store floodwater through onsite dams in the upper Vyrnwy catchment. The discussions concluded there was no real opportunity to incorporate this into the STT SRO design.

5 Drinking water quality considerations

Introduction

5.1 The Strategic Water Quality Risk Assessment (SWQRA) provides a high-level risk assessment using the AWCG methodology to identify limiting hazards and assess their risks across the water supply system for SROs. At each stage, from catchment to consumer (i.e., catchment, abstraction, conveyance, treatment, storage, distribution, and consumer), pre-mitigated risks are assessed with mitigation measures proposed and resultant post-mitigated residual risks assessed. This chapter provides a summary of the outcome from the risk assessment framework approach for STT at Gate 2.

5.2 Even though the STT comprises a raw water transfer between River Severn and River Thames, the SWQRA follows the catchment to consumer approach and assesses risks to consumers impacted by this SRO. In this respect the risks to Thames Water, Affinity Water, and Bristol Water consumers are assessed in this SWQRA. The risks to Severn Trent Water consumers impacted by Shrewsbury Redeployment are assessed in a separate risk assessment. The risks to upstream United Utilities consumers impacted by the releases from Lake Vyrnwy and Vyrnwy Aqueduct are assessed in a

separate report on North West Transfer (NWT) SRO. The risks to downstream Southern Water consumers are assessed as part of the Thames to Southern Transfer (T2ST) SRO work.

5.3 The differences in water chemistry between the Severn and Thames catchments drives the treatment requirements of the raw water. Pre-treatment of the raw water from the River Severn is proposed to ensure that there is a barrier to INNS transfer and that there is no deterioration in the River Thames raw water quality as a result of the transfer. Further treatment to drinking water quality standards is to be provided at the points of abstraction for Thames, Affinity, and Bristol Water intakes.

5.4 The changes to the SWQRA for STT between Gate 1 and Gate 2 are:

- New and updated information since Gate 1
- Additional Limiting Hazards at Gate 2
- SWQRA risk scoring methodology
- Completion of the SWQRA
- Gate 2 Risk Assessment outcome

5.5 The SWQRA was developed in collaboration and consultation with Severn Trent Water, United Utilities, Bristol Water, Thames Water and Affinity Water culminating in a workshop to present and agree the draft SWQRA spreadsheets. Consultation with the DWI was held at an initial meeting to outline the process and at a second workshop to present the SWQRA findings.

5.6 It is envisaged that the above SWQRA will be revisited, reviewed, and updated in light of new information as the project progresses through Gate 3 and beyond and will ultimately feed into the Drinking Water Safety Plans for the sites.

Risk assessment scenarios

5.7 The following risk assessment scenarios have been assessed considering a catchment through to consumers' tap approach, aligned with the Drinking Water Safety Planning methodology:

A. Deerhurst Pipeline Conveyance (Full Support – i.e., including effluent from Minworth WwTW)
B. Deerhurst Pipeline Conveyance (Without Minworth)
C. Cotswold Canals Conveyance (Full Support)
D. Cotswold Canals Conveyance (Without Minworth)
E. Bristol Waters intake on the Gloucester and Sharpness Canal

It is noted that the highest water quality risk would be if the Deerhurst Pipeline (with full support) was chosen as that would allow Netheridge WwTW effluent, albeit very much diluted, to enter the Gloucester and Sharpness Canal. In the case of Cotswold Canals conveyance scenarios Netheridge effluent will not enter the Gloucester and Sharpness Canal. This is a minor risk and is not a differentiator between the options.

These Risk Assessments were undertaken in Gate 1 and are updated in this Gate 2 work.

Limiting hazards at Gate 2

5.8 The limiting hazards at Gate 2 included all the Gate 1 hazards plus additional hazards included on the basis of new water quality data from the bespoke SRO monitoring programme which became available at Gate 2. It was however considered that the number of data points available at Gate 2 were not sufficient to exclude any of the Gate 1 limiting hazards although these will be reviewed at Gate 3 when more water quality data becomes available.

5.9 The following Gate 1 limiting hazards were reassessed at Gate 2:

- Risk assessment scenarios A&B
  E. coli, *Cryptosporidium*, Iron, Manganese, Pesticides – total, Metaldehyde, Benzo(a)pyrene, corrosivity (change of water chemistry), change in source type, Alkalinity, Pathogens – other bacteria, viruses, protozoa, Total Organic Carbon, Conductivity, Turbidity.
- Risk assessment scenarios C&D
  Limiting hazards for scenarios C&D were the same as for scenarios A&B with Bromide and Algae included as additional hazards.
- Risk assessment scenarios E
  Enterococci, *E. coli*, *Cryptosporidium*, Coliform bacteria, Iron, Nitrate, Nitrite, Pesticides – total, Metaldehyde, odour, taste, Geosmin/2-MIB, Pathogens – other bacteria, viruses, protozoa,

Ammonium, Conductivity, Turbidity, Clostridium Perfringens, Pharmaceuticals, Aluminium, Glyphosate.

5.10 The following additional limiting hazards included in the Gate 2 SWQRA based on the new or updated information (water quality data, DWSPs, reg 28 reports and process flow diagrams):

- Contaminants of Emerging Concern (CEC) – PFAS (PFOS & PFOA),1,4 Dioxane, NDMA
- Nitrite, PAH, temperature, and Invasive non-native species (INNS)

Contaminants of Emerging Concern (CEC)

5.11 PFAS (PFOA & PFOS), 1,4-Dioxane and NDMA are contaminants of emerging concern (CEC) which are typically associated with wastewater. However, there is no monitoring data for 1,4-dioxane or NDMA in the rivers, and although there is monitoring in some locations on rivers for PFAS, it is not available at all locations. The risk scores assigned reflect the uncertainty from this gap in data. It is expected that further water quality data, collected to support subsequent Gate stages, will reduce the associated risk assessment scores.

5.12 It is, however, recognised that global health advisories continue to change with regards to contaminants of emerging concern – with new DWI guidance for perfluoroalkyl substances PFAS issued in 2021 and most recently in July 2022. Furthermore in, June 2022, the US Environmental Protection Agency (EPA) announced the release of health advisories for four perfluoroalkyl substances with extremely low concentration limits in drinking water of 0.004 parts per trillion (ppt) for PFOA and 0.02 ppt for PFOS. Compliance with these new US limits, if applied in the UK, will be very challenging for most water treatment works.

Conclusions

5.13 Key conclusions from the Gate 2 assessment are:

- New limiting hazards have been included at Gate 2. These include Compounds of Emerging Concern (CEC) i.e., PFAS (PFOS, & PFOA),1,4-Dioxane and NDMA.
- The pre-mitigated risk scores at catchment for all but one of the limiting hazards are high (red) or medium (amber). The exception is conductivity with a low (green) risk score at catchment.
- Most of the hazards are mitigated at the treatment stage although there are some catchment, abstraction, and distribution stage mitigations.
- For most of the limiting hazards, the residual risks posed to consumer are low (green). There are, however, some limiting hazards will require further review and assessment. These are:
  - Limiting hazards which pose a risk that consumers could experience a change in perception of their water. These are generally related to change in source and include change in source type, taste, odour, and alkalinity. The mitigation is for these is early consumer engagement. This needs to continue throughout the project to keep the consumers informed with the developments and changes in the project that may impact on their water quality and to address their concerns. Further details on Customer engagement are contained in Chapter 9.
  - Corrosivity (change in water chemistry) will need further assessment regarding its impact on network corrosion for which the mitigation is treatment/blending.
  - Limiting hazards related to CECs. The current drinking water risk from these is deemed to be low; however, it is also possible that this may change in future. The SWQRA states that these are monitored going forward and the risks reassessed in light of the new water quality data.

5.14 The collaborative “catchment to consumer” approach of the SWQRA process is also aligned with the objectives of the Drinking Water Protected Areas. These objectives are:

- meeting the requirements of the Water Supply (Water Quality) Regulations 2016,
- the protection of the supply by avoiding deterioration in water quality to reduce the level of purification treatment required and for groundwater,
- the achievement of good chemical status and reversing upward trends in pollution, and
- the reduction of pollution at source as this is more cost-effective than removing pollutants or blending with clean water.

5.15 Overall, the SWQRA shows that the risks to drinking water quality from the limiting hazards identified can be mitigated by the measures proposed. However, for CECs and in particular PFAS, if in future the UK water quality regulations were to be tightened in line with recent USEPA guidance, compliance will be very challenging for most of UK new and existing water treatment works.

6 Environmental Assessment

Introduction

6.1 This chapter sets out a summary of the Gate 2 environmental assessments and their findings. The detailed assessments can be found in the Annexes. The Gate 2 environmental assessments cover a range of topics and build on the Gate 1 investigations. Their purpose is to improve the detail and breadth of evidence and reduce uncertainty with respect to the potential environmental effects of the STT SRO. The objective is to develop the solution to a standard suitable for submitting into final regional plans and final water resources management plans, in collaboration with associated regulators.

6.2 Based on the outcomes of all environmental assessments undertaken to date there are no 'showstoppers' that indicate that the STT system operation is not feasible due to environmental reasons, at this stage. Based on the current evidence base, environmental impacts have been avoided or mitigated, and opportunities for enhancements have been highlighted. In the topic sections below, the Gate 1 findings are set out with a summary of the action taken to address remaining concerns from that stage. The findings for Gate 2 are presented, with the further work recommended for Gate 3 to increase confidence and resolve remaining uncertainties.

Engagement and Collaboration

6.3 The representations made by stakeholders, and the recommendations presented in the RAPID final determinations for Gate 1[1] have been addressed during Gate 2. A series of "you said, we did" workshops were held with the regulators in December 2021 to discuss and incorporate the Gate 1 feedback, to agree methodologies and agree how key concerns would be addressed in the Gate 2 assessments. The key challenges and risks the solution faced at the end of Gate 1 were specifically with regard to compliance with the Habitats Regulations, and the need to provide sufficient evidence to confirm the conclusion of no significant impact on the integrity of the Severn Estuary Special Area of Conservation (SAC) and its linked habitat. The Gate 2 assessments also considered compliance with the Environment (Wales) Act 2016 and the Wellbeing of Future Generations (Wales) Act 2015. Both of these compliance risks have been reduced by the Gate 2 solution change.

6.4 To ensure a robust approach to the Gate 2 environmental appraisals, there has been extensive dialogue and engagement with multiple stakeholders. Monthly meetings and regular workshops have been held between the environmental assessment team and the environmental regulators National Appraisal Unit: The Environment Agency (EA), Natural Resources Wales (NRW) and Natural England (NE). Further to this, there has been engagement with multiple stakeholders, including river and canal partnerships and trusts, local planning authorities, regional resource groups (WRSE, WRW) and technical working groups.

6.5 This engagement has helped to shape and challenge the environmental assessments, to ensure that the STT solution is feasible and supported by stakeholders. Stakeholder input has been sought from an early stage and this engagement will continue and extend as the SRO progresses. It has also helped ensure best value outcomes, and opportunities to provide social and environmental benefits. Environmental stakeholders and regulators who participated in workshops and discussed the assessment results have commented on the good depth and breadth of assessments undertaken and rated the assessments in their monthly progress RAG as 'Green' confirming no issues/issues with mitigating actions being applied, and that there is no reason not to progress to Gate 3.

Solution Change

6.6 In Gate 2, the environmental impacts and risks were further assessed using data from extensive surveys and monitoring programmes, the outputs of 1D hydraulic and water quality modelling (using a representative Severn regulation water release pattern provided by the EA), and results from in-channel habitat modelling. Using this evidence, the Gate 1 solution of a direct release from Lake Vyrnwy of 75Ml/d and a bypass transfer to the River Vyrnwy at Llanymynech (105Ml/d) was determined not be compliant under the Habitats Regulations or the Water Framework Directive. This conclusion was based on the likely significant adverse effects that this combined operation (i.e., with compensation flow, flood draw-down and river regulation) could have on the integrity of the Severn Estuary Special Area of

1 RAPID (2021) Standard gate one final decision for River Severn to River Thames transfer

Conservation (SAC) and its functionally linked habitat. This conclusion informed a change in the engineering design to avoid these adverse effects.

6.7 The altered SRO design for Gate 2 now comprises a significantly reduced direct release volume of 25Ml/d into the River Vyrnwy, with a bypass transfer of 155Ml/d to the River Severn (Section 3). This change avoids any significant impacts to the structure and function of habitat which support the migratory fish of the Severn Estuary, thereby avoiding undermining the conservation objectives of the site, and avoiding a compliance risk with Welsh legislation. This change in solution was welcomed as very positive by regulators[2] as it showed the interaction of the environmental and engineering teams and the influence of environmental concerns upon the SRO design. The altered SRO is a demonstrative example of where the STT solution has been changed to minimise the potential for adverse environmental impact.

Approach

6.8 RAPID issued guidance[3] to describe the Gate 2 process and set out the expectations for solutions following the standard Gate 2 timescales. The environmental assessments have been undertaken using the methodology and guidance published on behalf of the All Company Working Group (ACWG)[4], and the Environment Agency (EA) Invasive Non-Native Species (INNS) risk assessment tool[5]. The ACWG methodology is aligned to the Water Resources Planning Guidelines (WRPG)[6] so that the approach is consistent with the evaluation of potential effects on environmental aspects and drinking water quality.

6.9 Figure 6.1 shows the investigations undertaken at Gate 2 and their interactions, in order to show the scope of work across both environmental and engineering disciplines. Reporting for the environmental assessments has been undertaken in a phased way to account for, and incorporate, all previous assessments, data collection and feedback. The evidence reports were produced first and set out the data and evidence used in the assessment. The assessment reports were then produced using the evidence to determine the potential effect of the STT system on the physical environment, water quality and ecological receptors. Finally, based on the evidence and assessments, the informal statutory reports and assessments were produced as required to meet the combined RAPID and regulatory guidance, and comply with future statutory assessments for the SRO.

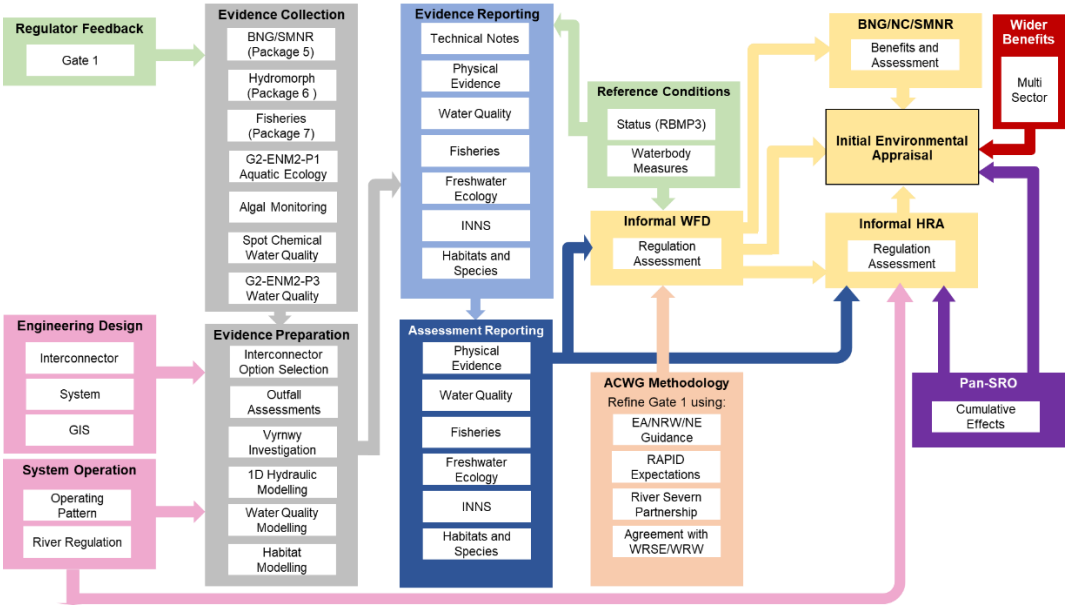


Figure 6.1 Flow chart showing the scope of Gate 2 investigations for STT and their interactions

2 As recorded in the minutes of the monthly STT Regulator Meeting (June 2022)

3 RAPID (2022) Strategic regional water resource solutions guidance for gate two

4 Mott MacDonald Limited (2020). All Companies Working Group WRMP environmental assessment guidance and applicability with SROs. Published October 2020

5 Environment Agency (2021) SRO Aquatic INNS Risk Assessment Tool (SAI_RAT)

6 Ofwat (2020) draft Water Resources Planning Guideline (WRPG): Working Version for Water Resource Management Plan 2024

Water Framework Directive (WFD) Assessment

6.10 The Gate 1 informal assessment identified potential non-compliance with WFD objectives. The further development of the STT system's operating rules and treatment solutions, together with additional bespoke aquatic habitat assessment, water quality monitoring data, and water quality modelling, have now been completed as part of Gate 2. There are also important updates that have been made by the project team to the Gate 1 approach in order to reflect the latest position of the EA and NRW on testing WFD compliance of water resources options, and also to align the baseline to the draft River Basin Management Plan 3 (RBMP3). The STT SRO design has been altered to reduce potential adverse effects on the integrity of the Severn Estuary SAC and its functionally linked habitat, which has had a positive influence on the informal WFD assessment.

6.11 It is considered that there is sufficient environmental water quality evidence available to perform the Gate 2 assessment. The hydraulic modelling and outputs for the River Vyrnwy, River Avon and River Severn reaches are generally assessed to be robust and a medium confidence is placed on the results. Further refinement of the hydraulic modelling of the River Thames is required at Gate 3 to increase the confidence in the outcomes.

6.12 The conclusion of the Gate 2 informal assessment is that the effects of the STT SRO on the River Vyrnwy, and the River Severn reaches upstream of the River Avon confluence, along with tidal reaches, are assessed to be WFD compliant. In these reaches, there is no pathway of environmental water quality change. Potential changes in velocity and depth with the altered Gate 2 solution are now considered not to be of a magnitude to result in adverse effects on aquatic ecology or river morphology.

6.13 The Gate 2 WFD assessment identified that the early phase STT solution was compliant with WFD objectives. There is however potential for introducing impediments to target status in four waterbodies in the River Avon, in the reach from Stoneleigh to the confluence with the River Severn. The risks are associated with the 115Ml/d advanced treated effluent transfer from Minworth WwTW during a supported STT operation, based on specific pollutants / chemical status (Objective 2 introducing impediments). This potential non-compliance is a risk to future permitting requirements and will be subject to continued assessment to consider the effect of further developed operating rules and treatment solutions as part of the consenting process.

6.14 In the ~140 km of the River Thames from Culham to the tidal limit at Teddington, modelled water quality results predict a benefit to dissolved oxygen saturation, and a small benefit (reduction) with regard to concentrations of PFOS and the polyaromatic hydrocarbon benzo(g,h,i)perylene. However, any betterment from the STT solution would not lead to EQS (Environmental Quality Standards) being achieved in the River Thames for these chemicals.

Informal Habitats Regulations Assessment (HRA)

6.15 Although a full HRA for a solution is not required until a planning and/or permit application is submitted (or expected Development Consent Order (DCO) for STT), the RAPID guidance strongly recommended that the principles of a HRA were followed to reduce the risk of non-compliance at the application stage. The Gate 2 assessment therefore followed this approach and assessed possible source-receptor-pathways through which any effects from activities associated with the STT solution may cause an Adverse Effect on Integrity (AEoI) of a European site.

6.16 The informal HRA has been completed with updated monitoring data and modelling results and in view of the relevant conservation objectives for the Severn Estuary (SAC, SPA and Ramsar site) which were provided by NE in May 2022 in a position statement. The altered SRO design has reduced the potential AEoI of the Severn Estuary SAC and its functionally linked habitat.

6.17 With the implementation of appropriate mitigation measures, no AEoI were identified due to construction impacts of any element of the STT solution, specifically the interconnector, Vyrnwy Bypass, and the proposed intake and outfall locations. This conclusion is based on (i) there being no suitable functionally linked habitat within the proposed construction corridors, (ii) the distance from the construction impact to European sites; and (iii) the impacts having only localised effects.

6.18 The available data (modelled and measured) indicate that changes in flow, velocity, and depth associated with the operation of the STT system is measurable but the impact is insignificant and will not result in change to the quality or quantity of supporting habitat within the River Severn (and tributaries) or within the Severn Estuary. As such, no AEoI have been identified. This conclusion is

based on the fact that the hydraulic changes (including pass forward flow into the estuary) are of a magnitude that are within the interannual variations that would be observed naturally under baseline conditions.

6.19 The effect of the STT solution on pass-forward water quality into the Severn Estuary indicate changes in nutrient concentrations are very low and not detrimental. With regards to the regulated nutrient for transitional waters, there would in fact be an overall reduction in load passed forward due abstraction of water at Deerhurst. There is potentially an increase in the load (and concentration) of some chemical determinands, but the increase is considered to be of a magnitude that would not result in a risk of AEoI. The assessment has incorporated the expected restrictions on the use of selected determinands, and improvements in analysis and treatment in future.

6.20 Uncertainties remain for a number of determinands that are known to create olfactory inhibitors that could affect the migration and reproduction of many fish species. Current knowledge of the risks associated with many of these determinands are based short-term laboratory exposure studies, with limited data showing potential effects in the freshwater, estuarine and marine environment. Therefore, to address these uncertainties the pan-SRO water quality monitoring programme will continue to add to the evidence base required to complete a formal HRA as part of the consenting process.

Initial Environmental Appraisal (IEA)

6.21 The IEA undertaken in Gate 2 comprises an initial high-level assessment of environmental feasibility of the STT solution, although is cognisant of the likely EIA requirements at Gate 3. Some aspects of SEA and EIA are common to both requirements, including the consideration of similar environmental topics as set out in Schedule 2 of the SEA Regulations[7] and Schedule 4 of the EIA Regulations[8]**.** The STT appraisal therefore used these common topic areas to identify environmental constraints and opportunities that can be refined for SEA (in feeding into regional plans) and in EIA (as part of the consenting process).

6.22 An environmental baseline was updated for the solution footprint with all available data collected as part of the solution assessment, and the additional evidence available across the workstreams. The key sensitive receptors across each SEA/EIA topic were then assessed using a RAG system to summarise the appraisal. Across all topics and receptors, there are no 'red' constraints identified in the construction or operation of the STT solution.

6.23 The cumulative effects and in-combination assessment draws on the proposed approach outlined in the Gate 2 Environmental Appraisal - Cumulative Effects Methodology (December 2021)[9], updated in February 2022[10]. The specific cumulative effects assessment incorporated local and site-specific information including large development allocations within Local Plans and larger planning applications. For Gate 2, the outcome of the assessment is that there are no significant cumulative effects identified with other developments or plans.

Environmental options appraisal

6.24 The qualitative environmental screening of the shortlisted options for the interconnector adopted a RAG system to demonstrate how each option performed against the assessment criteria. Based on the assessment results, the Deerhurst Pipeline was chosen as the preferred option to deliver a 300Ml/d water supply transfer. This option had no major environmental constraints and scored more favourably against criteria that looked at the potential risk during STT construction and operation of invasive and non-native species and flood risk.

6.25 The STT options appraisal considered the core objective of interconnector which is to transfer water from the River Severn to the River Thames to meet water supply needs in the South East. The assessment also recognised that the canal options have the potential to deliver a dual-purpose multi-sector scheme, not only to provide a mechanism for water transfer but also supporting the restoration

7 Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment ("SEA Directive")

8 Directive 97/11/EC amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment ("EIA Directive")

9 Mott Macdonald (December 2021), Gate 2 Environmental Appraisal, Cumulative effects methodology

10 Mott Macdonald (February 2022), Gate 2 Environmental Appraisal, Cumulative effects methodology

of the Cotswold Canals for navigation. As a result, a 'potential futures' study was undertaken to consider whether the selection of this option would be a better outcome for society and the environment than a pipeline transfer. The conclusion of the study was that, despite the increased monetizable benefits attributable to scenarios where navigation is enabled, they did not significantly reduce the higher cost of a canal transfer. When qualitative factors such as resilience and environmental impacts were considered, the pipeline was also shown to be the preferred option. It should be noted that these are the findings for Gate 2 only: they will be further developed alongside stakeholder consultation for Gate 3.

6.26 All Vyrnwy bypass option route alignments were optimised from Gate 1 and resulted in significant improvements (reductions) in the environmental constraints associated with each route. All optimised options were assessed to have a neutral or minor issue or constraint regarding all other criteria. The preferred option, pending further stakeholder engagement, was chosen based on the output of the engineering assessment of comparative cost and the non-monetary multi-objective decision analysis undertaken in the options appraisal. It was also the preferred route from an environmental perspective and chosen for the altered Gate 2 solution.

Biodiversity Net Gain (BNG)

6.27 RAPID called for an assessment of BNG for SROs in England, to support the goals of the Government's 25-year Environment Plan and meet the requirements of the 2021 Environment Act. An assessment of habitat loss (both temporary and permanent) associated with the SRO has been calculated, including the 'uplift' necessary to achieve the required 10% BNG. Given that the STT system is still at feasibility and concept design stage in Gate 2, it should be noted that these calculations are very much preliminary as the detailed route and site selection work has yet to be completed where there may well be the opportunity to avoid more valuable habitat.

6.28 Land that would be temporarily disturbed as a result of construction activity was calculated to be ~391 ha for the whole STT system. The mitigation hierarchy will be followed during the consenting process and this land would be restored to its previous land use and condition. Achieving the requirement of no net loss of habitat would require an area of ~89 ha, which increases to ~98 ha when considering the need to achieve the target of a minimum 10% uplift in BNG. Temporary construction effects on rivers requires the enhancement of 0.18 km length of riverine habitat, with an additional 0.25 km of enhancement to provide BNG due to construction effects. The areas for enhancement are all located within 1 km of the affected rivers. The scale of the land required for BNG is thought to be comparable with the offsite habitat creation needed by other developments.

6.29 The Gate 2 assessment has identified areas of land which may offer suitable locations for mitigation using a scoring approach. In Gate 3, the collection of additional site and ecological data to ground truth the tool will reduce assumptions made about existing habitat quality. This new evidence plus the further developed SRO design, in terms of detailed routing, will give rise to opportunities to reduce the area of land affected.

Sustainable Management of Natural Resources (SMNR)

6.30 The principles of SMNR aim to utilise natural resources in a way, and at a rate, that maintains and enhances the resilience of ecosystems and the benefits they provide. Following the SMNR principles will also help to achieve the Wellbeing Goals set out in the Well-being of Future Generation (Wales) Act 2015, to improve the social, economic, environmental and cultural wellbeing of Wales. While there is no construction activity in Wales as part of the STT solution, the SRO was assessed against the SMNR principles and Wellbeing Goals. Numerous areas for potential biodiversity improvement interventions were identified throughout the STT solution footprint, with the outputs showing a clear link to the Mid Wales Area Statement themes of 'Improving biodiversity', 'Sustainable land, water and air', and 'Climate emergency – adaptation and mitigation'.

Natural Capital Assessment (NCA) and wider benefits

6.31 A NCA was undertaken at the options appraisal and overall system level to support the identification of best value solutions using ACWG methodologies[11,12]. The initial assessment of the monetised

11 All Company Working Group (2020). WRMP environment assessment guidance and applicability with SROs

12 Environment Agency (2020) Water resources planning guideline 2024 supplementary guidance- Environment and society in decision-making (England).

ecosystem services provided by the STT solution in relation to climate regulation, natural hazard regulation and agriculture over 80 years is £1,237,091. At Gate 2, this Net Present Value is related to the assessment of biodiversity and high level opportunities of habitat gain required (both on and off site collectively). Not all ecosystems services can be monetised at this stage because of data limitations so there is potential for even greater benefits related to both environmental and socio-economic net gain during Gate 3.

6.32 Feedback from the regulators on the Gate 1 submission identified the need to provide more detail in terms of biodiversity resilience and net gain opportunities, and to further "explore opportunities the STT SRO could deliver". In Gate 2, this has involved the assessment of the potential wider multisector benefits of the STT solution, including societal, economic, and natural benefits and opportunities (Welsh and English ambitions), accounting for local ambitions and opportunities that could be supported as part of the STT solution. This assessment comprised: (i) 'blue skies' thinking underpinned by knowledge gained from surveys since Gate 1; (ii) a series of stakeholder workshops; and (iii) the development of a robust geospatial analysis to examine current plans and identify potential opportunities.

6.33 By collating information and applying metrics to each ecosystem service, areas across the STT solution catchment area were identified that collectively could provide additional benefits for people and the environment. Heat maps showed clear areas that could become particular focus areas for achieving the widest set of benefits.

6.34 The geospatial approach allows for the inclusion of other data sets at different scales throughout Gate 3 and beyond, enabling further and / more detailed assessment as new or updated data become available. The outputs provide a platform for discussion with stakeholders about the wider benefits that could be achieved, noting that it is critical to be aware that many plans and projects being currently developed are working at different time scales to the STT programme. As such, care will need to be taken regarding 'the here and now' opportunities which may not be directly applicable to demonstrate benefits for the STT solution once implemented given the future date of its proposed implementation.

Carbon

6.35 The carbon assessments methodology for the STT SRO have followed PAS2080 principles in its carbon management approach through the emission reduction hierarchy: build nothing, building less, build clever, build efficiently. The baseline carbon of the SRO was estimated based on the quantification of both embodied (capital) carbon and operational carbon. Emissions hotpots were identified for further evaluation and prioritisation of mitigation efforts, such as through material selection, innovative designs and opportunities for energy efficiency and generation. Longer-term mitigation opportunities have been covered by the ACWG Carbon Ambition which has identified a consistent view across SROs how these external systems may decarbonise in the future to inform future decarbonisation potential and engagement priorities for individual SROs.

Whole Life Carbon (WLC) assessment

6.36 The WLC assessment has been carried out based on a utilisation of sweetening flow for 80% of the time and full flow for the remaining 20%. For embodied carbon, these tools are supported by publicly available data, including the University of Bath's Inventory of Carbon and Energy on construction materials, the Inventory of Carbon and Energy (ICE) and the Civil and Engineering Standard Method of Measurement (CESMM4) Carbon & Price Book 2013. For operational carbon, specific emission factors are allocated per annual quantities to estimate emissions from energy use by the option's infrastructure and building-integrated systems. They also represent process carbon emissions arising from the option to enable it to operate and deliver services, such as chemicals for treatment. Emission factors are based on the UK Government GHG Conversion Factors for Company Reporting and the UKWIR Carbon Assessment Workbook (CAW).

6.37 The WLC assessment considered the PAS2080 boundaries "before use stage" and "use stage", taking into consideration capital carbon (e.g., Scope 3) emissions and operational carbon (e.g., Scope 1 and 2) emissions for 80 years of operations to align with the whole life costing assessment. Capital carbon replacement emissions have been considered and estimated based on a standard asset life category and associated predicted asset life (years) from the ACWG Cost Consistency report to each asset input line for cost and carbon. A full capital replacement has then been assumed at the end of the predicted asset life.

6.38 The term capital carbon is used in this WLC assessment instead of embodied carbon, as recommended by PAS 2080, as it accords with the concept of capital cost. Embodied carbon is mostly used at a product or material level, while capital carbon has greater relevance at an asset level, related to the GHG emissions associated with the creation, refurbishment and end of life treatment of an asset.

6.39 A summary of the capital carbon and operation carbon for Interconnector and the mitigation works from Vyrnwy Bypass Pipeline and Shrewsbury Redeployment, are summarised in Table 6-2 for each of the options. Note that due to the gravity main design of the Vyrnwy Bypass Pipeline there are minimal energy requirements related to that element, which reflects the significant lower operational carbon emissions compared to the Interconnector and the Shrewsbury Redeployment.

Emissions hotspots

6.40 Pipelines: across all options, the pipeline elements represented the largest carbon hotspots, accounting for between 87 – 96% of the embodied carbon due to the pipe material itself, as well as the construction effort to install these and associated ancillary items. The existing design assumes a cement-lined steel pipe option and current construction approaches, such as open-cut installation using typical diesel power excavation plant, and trenchless crossings.

Table 6-2 WLC emissions for the STT SRO (excluding replacement of assets at the end-of-life stage)

Gate 2	Options	Capital carbon (tCO2e)	Operational carbon (tCO2e)	WLC Cost (£M)
Deerhurst Pipeline	300 Ml/d	243,191	139,258	81.5
	400 Ml/d	292,331	185,555	101
	500 Ml/d	325,863	231,634	116
River Vyrnwy Bypass Pipeline	River Severn discharge	15,763	28.5	4.19
Shrewsbury Redeployment		285	26,851	3.87

6.41 Treatment works and pumping stations: although a significantly smaller emissions contributor compared to pipelines, they still form a substantial hotspot at 5% of capital carbon emissions. These assets are dominated by concrete and steel reinforcement in these structures.

6.42 Power consumption: it is a significant emissions hotspot during the early operation of the STT. Over time, the significance of power-related emissions will reduce as the grid decarbonisation projects take effect.

6.43 Chemicals: chemical dosing of ferric and polymers forms a substantial part of the annual operational emissions. It will remain a significant emissions source throughout the assessment period due to their inherent carbon intensity and assumption that these will not substantially decarbonise over time.

6.44 The STT has prioritised efforts to reduce emissions rather than focus on an emissions mitigation plan. Both reduction and mitigation efforts have been split into two areas:

- Opportunities directly under the control of the design team
- Longer-term opportunities where the scheme and sector can influence external systems and supply chains to decarbonise major components of the SRO

Some of the opportunities are highlighted as following:

6.45 Material selection: The pipe material selection is a key area for carbon emissions reduction. It is currently driven by the diameter of the pipe at the high-pressure ratings required, making steel the default choice. Design standards and specifications have also limited pipe material selection. There is the opportunity for the material choice to be reviewed at later Gate stages in conjunction with other aspects of the pipeline, such as pipe diameter reduction, which would offer lower carbon alternatives.

6.46 Backfill and reinstatement: Where possible, use of as-dug material will be used for backfilling. Gate 2 carbon assessment assumes imported backfill for the pipe surround and as-dug material for the remaining trench. Once further detail is known at later Gate stages, an updated assessment of the imported material required for the pipeline can be assumed and will potentially lead to carbon savings.

6.47 Power supply provision: A further design optimisation opportunity would be to reduce the power supply infrastructure for pumping stations. Pumping stations have been designed to have dual supply. Considerations to optimise it to single supply for the high and low-lift pump stations along the pipelines can be explored at Gate 3 where discussions need to account for the risk to the operation of the SRO.

6.48 Water Treatment Works (WTW): There is potential to consider nature-based solutions as an alternative treatment solution with a hybrid settlement lagoon/constructed wetland followed by Mecana cloth filters being explored. This will be explored further at Gate 3 and has the potential to reduce operational power and chemical consumption, as well as potentially provide BNG.

6.49 Optimising energy efficiency and maintenance activities to prolong asset life/performance: The design of the Deerhurst Pipeline has optimised operational costs on the assumption of 20% utilisation at peak flow, which results in energy and material efficiency. Further optimisation profiles can be assessed for potential optimisation when more detailed utilisation expectations are determined.

6.50 Sweetening flow scenario: Further investigation into whether the volume of the sweetening flow can be reduced should be conducted to determine potential carbon reductions.

6.51 An assessment of the energy recovery possibilities was conducted based on the highest transfer capacity of 500 Ml/d of the Interconnector. The current design of gravity-main pipeline offers very limited energy recovery opportunity due to low available head (ca. 13m) at the end of the pipeline. However, the lift pumping station at Deerhurst showed potential for significant energy recovery, with hydro power outputs ranging from 1MW to 4MW, depending upon the particular discharge, and overall energy recovery ranging from 16% at higher flows through to 58% at the lower flows.

6.52 A hydro power generation potential has also been undertaken for the Vyrnwy Bypass Pipeline. The potential annual energy generation ranged from 317 MWh/yr to 826 MWh/yr depending on the pipeline route and flow. In addition, it was demonstrated that for all pipeline routes it would be economically feasible to provide energy recovery turbines for all flow capacities, particularly for the cases with a flow rate of 180 Ml/d.

6.53 The WLC assessment of the STT SRO is in line with the RAPID Gate 2 guidance report, considering assessment of key emission hotspots, opportunities to reduce emissions within the design, such as inclusion of material selection choices, and innovative approaches for renewable energy generation. It acknowledges the significant opportunity to work with the supply chain to support accelerated decarbonisation to help further reduce the carbon impact. As part of the ongoing review of opportunities on the STT SRO, the project will continue to build an understanding of the carbon emissions to ensure the procurement process has steps in place to drive down emissions.

7 Programme and planning

Project plan

7.1 The Gate 2 programme has been developed by integrating technical, commercial, planning and stakeholder workstream activities into an overall SRO programme. This also incorporates the principal WRMP24, DCO, DPC and construction activities. Comparisons have been made across other SROs of key activities, dependencies and durations to provide high-level benchmarking, a level of consistency, and assurance.

7.2 The timeline for Gate 3 is based on ensuring STT could be “construction ready” in AMP8 (2025 to 2030), if required. However, other later delivery timescales may be appropriate which will be confirmed once the regional and WRMP24 plans are finalised in 2023.

7.3 A flexible approach is therefore proposed with a “Mid-Gate3 Checkpoint” at the end of 2023 to confirm and adjust the progression of the STT project, as appropriate, once the WRMP24 plans are finalised.

7.4 Figure 7-1 summarises an overall integrated project plan to show the earliest timeline to achieve construction readiness within AMP8. The earliest that construction-ready status could be achieved for the SRO would be by Q3 2028 and by Q3 2033 for commissioning completion.

7.5 It should be noted that there is no quantified schedule risk allowance in this programme and this programme represents an ‘earliest available water date’. At Gate 3 the assessment of schedule risk will be developed further in line with the recommendations of the Treasury Green Book to account for both known and unknown risks in the delivery of future activities.

7.6 The overall critical path activities for the STT Interconnector delivery are:

- Finalisation and approval of WRMP24 plans in 2023 and decision to proceed past the Mid-Gate3 Checkpoint

- the Interconnector DCO consenting pre-application process;
- DCO examination and determination;
- Upon DCO granting of consent, feeding any conditions and requirements from the DCO consent into the DPC preferred bidder appointment process,
- Preparation and submission of a final business case (control point F) approval and Competitively Appointed Provider (CAP) award;
- the Interconnector contract mobilisation, detailed design, discharge of consents, construction and commissioning.

7.7 Table 7-1 provides a summary of key milestones and their earliest delivery. The principal programme interdependences and constraints are given in Table 7-2 and the principal programme assumptions are given in Table 7-3.

Table 7-1 Earliest Project Delivery Milestones

Milestone / activity	Principal Outputs	Date**
Gate 2 submission / Gate 3 commencement	• Feasibility and options selection	Nov 2022
Mid-Gate 3 Checkpoint	• Decision on SRO progression, and any changes to funding / partner participation • Stage 1 engagement activities undertaken • DPC control point B complete and control point C in preparation	Dec 2023
Gate 3 end / Gate 4 commencement	• Decision point to procced with preparing DCO and DPC tender documentation • Stage 2 engagement activities undertaken • Preliminary Environmental Report drafted • Preferred single route option and sites identified • Preparation towards DPC control points D & E	Q1 2025
Gate 4 completion	• Statutory consultation undertaken and ready to submit DCO application • DPC control points D and E issued and ready to go to market	Q3 2026
DCO consent	• Granting of a Development Consent Order • Return and assessment of DPC tenders	Q1 2028
'Construction ready'	• DPC control point F & Competitively Appointed Provider (CAP) award	Q2 2028
Complete commissioning	• STT 'Unsupported' deployable output with supported sweetening flows (Netheridge)	Q3 2033
** date quarters are for calendar years, e.g. Q1 is January to March.		

Table 7-2 Principal programme dependencies and constraints

Interdependency/ constraint	Description
Regional planning and WRMP24 processes	The programme is dependent on the relevant regional planning and final WRMP24 approvals process. The outcome of this process will determine the need, timing, and phasing of STT, with a decision point proposed at the Mid-Gate3 Checkpoint on how the project then proceeds.
Ofwat/RAPID decisions	The programme will be affected by the timeliness and nature of decisions made by the regulator at Gate 2, Mid-Gate3 Checkpoint and end of Gates 3 and 4 as to whether the STT SRO proceeds or otherwise.
DPC and DCO	The DPC (control points B to E) run in parallel with the consenting process. The development and agreement of Invitation to Tender documentation for control point D is a significant work activity and needs to be commenced during Gate 3 to avoid constraining the programme. The DPC award is also dependent on the granting of a DCO.
Netheridge scheme development	The provision of Netheridge treated effluent is critical to the operation of the SRO as it allows the abstraction of Interconnector sweetening flows from the River Severn during low flow conditions in the River Severn (i.e. below the hands-off flow). Netheridge design development, consultation, environmental, consenting and procurement activities need to be undertaken in step with the Interconnector activities as likely to be treated as 'associated development' within the interconnector DCO with oversight from the proposed Gate 3 STT System Co-ordination.

Planning and consenting route

7.8 At Gate 1, a provisional consenting strategy for the STT SRO was presented. The planning and land strategy has been further developed at Gate 2, with the key outcomes and conclusions of that strategy are set out below.

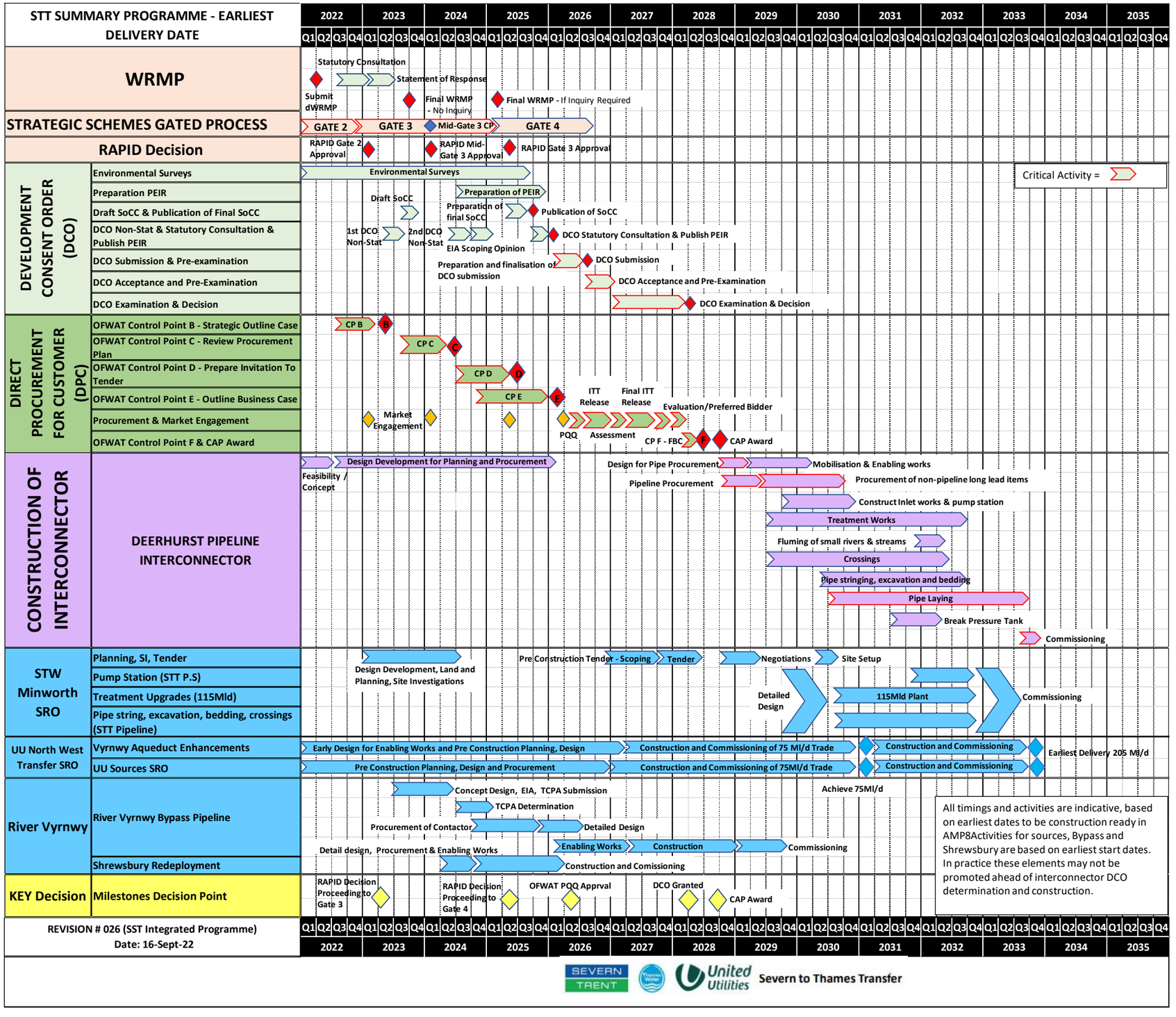
Table 7-3 Principal programme assumptions

Assumption	Description
SRO requirement	STT is required to proceed as part of the regional and WRMP24 plans.
WRMP public inquiry	If there is WRMP24 public enquiry, development of the SRO can proceed in parallel, and the outcome of the enquiry does not change the WRMP24 options selection.
Gate 3 target delivery date.	Assume the STT project proceeds into Gate 3 on the basis of being 'construction ready' in AMP8, but with a Mid-Gate 3 Checkpoint to review this assumption and the requirement and pace of delivery.
Environmental Impact Assessment (EIA) and DCO	Assume the Interconnector will require an Environmental Impact Assessment and consent through a Development Consent Order
DPC	Interconnector is procured through a DPC model, with a "late" tender model for appointment of a CAP undertaking post-consent detailed design, build and operation.
Option type	The programme is based on the assumption that consultation on the SRO will confirm the Interconnector as a direct pipeline solution (as opposed to a pipeline solution with sections of canal refurbishment). The outcome of future engagement and consultation may change this assumption.
Non-statutory consultations	Two non-statutory phases of consultation: Stage 1 on route corridors and alternatives; Stage 2 on a preferred route, construction, and permanent works.
WRMP24 finalisation	WRMP24 plans will be finalised and approved in 2023 and decision to proceed made at the proposed Mid-Gate3 Checkpoint.
Continuity through gates	Work progresses immediately through the Mid-Gate3 Checkpoint, Gate 3 and Gate 4 without significant pauses for regulator or other reviews and approvals.
DCO acceptance, determination and requirements	DCO is accepted and determined (granted) on first submission and there are no exceptional or unexpected material changes or restrictions from the process that then delay contract award to the CAP.
Vyrnwy Bypass and Shrewsbury Redeployment	The critical path runs through the interconnector development, consenting and procurement activities. It is assumed the bypass and Shrewsbury Redeployment are related to STT support sources (as opposed to support to the WRW region) and are independent of the programming of the STT Interconnector.
Construction ready	Construction ready means: DCO and other primary consents are given, and construction contract award to a CAP. This is notwithstanding that a construction contract will include mobilization activities, discharge of secondary consents/requirements, detailed design, enabling works and other incidental works ahead of the main construction activities. The SRO will be deemed as construction ready at contract award.
Commercial Agreements	Commercial agreements between the partners are in place in time to enable both (i) joint working through the SRO development stages and (ii) commercial bulk supply agreements are established in time to enable commercial DPC procurement activities to proceed.

Work done to date to support the proposed land and planning process

7.9 The planning and land consenting strategy is set out in Annexes. This includes the preferred planning routes to consent for the STT SRO options under consideration, together with planning risks and mitigation and the recommended next planning steps, looking beyond Gate 2. Also included are further assessments of national and local planning policy, and existing and emerging development proposals relevant to the STT SRO. This incorporates reviews against the draft National Policy Statement for Water Resources Infrastructure, November 2018, and adopted and emerging Development Plans. Planning leads for the teams working on SROs with a potential inter-relationship with STT have ensured that there has been discussion and collaboration over the consent strategies for the different SROs, with a particular focus on the inter-relationships and physical infrastructure interfaces between the SROs. This has included the other SROs that comprise the STT system, SESRO, and T2ST. During June and July 2022, the planning strategy was presented to the relevant local authorities within which the STT SRO options lie.

Figure 7-1 Summary programme for earliest delivery date



Preferred planning route and key planning steps

Interconnector

7.10 Section 28 of the Planning Act 2008 as amended (PA2008) sets out when a water resource project should be considered a Nationally Significant Infrastructure Project (NSIP). Section 31 of the PA2008 states that development consent is required for that development that is or forms part of an NSIP. Work undertaken in Gate 2 has confirmed that that the Interconnector would be a project that is or forms part of a water resource NSIP. The criteria set out in Section 28 of the PA2008 would be met as the development would be carried out in England by one or more water undertakers, the deployable output would exceed 80 million litres per day, the development will enable the transfer of water resources between river basins and water undertakers' area in England, and the development does not relate to the transfer of drinking water. The Interconnector would therefore need to be consented by way of a Development Consent Order (DCO).

7.11 The DCO would consent the early phase of the STT SRO, which is without the inclusion of most of the support options that augment flows in the River Severn. For a Deerhurst pipeline option, the Interconnector requires a guaranteed source of sweetening flows for it to operate. The Gate 2 work has determined that the Netheridge WwTW could provide the discharge to the River Severn to facilitate that sweetening flow. If this continues to be the case, then it is recommended that the Netheridge WwTW would appropriately be included as 'associated development' to the DCO. This approach, together with consenting options under the Town and Country Planning Act as amended (TCPA) will be further explored during Gate 3 to determine the timing and optimal consenting and delivery route for the Netheridge WwTW.

7.12 The other SROs that combine to form the STT system and will facilitate the provision of supported flows are physically distinct and separate schemes. Therefore, they need not be consented as part of the Interconnector DCO. Planning consent for these separate schemes, either through DCO, TCPA applications or permitted development (where EIA is not required), will be sought at the appropriate time to allow their timely delivery.

7.13 Through the Interconnector DCO there will be an opportunity to set out the operational rationale for the STT system both in relation to the "need case" and in terms of water availability and infrastructure provision. For the other STT system projects and SROs, it will be necessary for them to reflect on their role within the overarching operational rationale and, where EIA Screening or full EIA is required, assess any cumulative environmental impacts that may arise.

7.14 Whilst there are limited conjunctive benefits, the Interconnector is not required to support SESRO or vice versa, so there is no direct water resource relationship between either option. However, it is understood that there may be opportunity for the Interconnector to utilise or combine with the discharge infrastructure at Culham that would be developed in connection with SESRO. Depending upon the eventual delivery timescales and DCO programme of the options, it could be that any overlapping discharge infrastructure for the Interconnector is consented by way of separate coexisting consents or could be included as part of the SESRO or STT DCO as either part of the NSIP development or associated development. The latter would require funding and other issues to be resolved and early consents for any STT related infrastructure would need to be secured on the basis that they do not prejudice any decisions that would need to be taken on subsequent applications for the Interconnector at a later date. This is capable of being satisfactorily accommodated through DCO applications.

Vyrnwy Bypass and Shrewsbury Redeployment

7.15 The Vyrnwy Bypass and the Shrewsbury Redeployment do not automatically meet the NSIP thresholds set out in Section 28 of the PA2008. Both relate to the provision of future supported flows and are not needed for the initial unsupported Interconnector element to become operational. Furthermore, they are physically separate from the Interconnector. On this basis, there is no requirement at this stage for these developments to be included as part of the Interconnector DCO. The Vyrnwy Bypass would, however, require delivery of the North West Transfer SRO prior to its operation. This is considered to be a sequencing issue and not one that requires the Vyrnwy Bypass and the North West Transfer SRO to be linked in planning terms as they are physically separate and distinct schemes. Whilst there would be the opportunity to argue that the Vyrnwy Bypass and the Shrewsbury Redeployment elements could

be considered a Project of National Significance through a PA2008 Section 35 Direction, at this stage it is not considered that they are of sufficient scale or complexity to warrant this.

7.16 The elements would either be consented through TCPA applications or at least in part permitted development depending upon the scope of the proposed development and need for EIA.

Strategy for obtaining other regulatory consents

7.17 For the Interconnector the DCO process enables land acquisition along with many other consents and powers to be dealt with at the same time. The DCO application may, however, need to be supplemented by other applications because a specific consent cannot be obtained in the DCO; or a consenting authority declines to allow a consent to be obtained in the DCO; or it is not desirable, or it is inappropriate to include a consent within the DCO due to the stage of design development and the level of detail available.

7.18 Although at this early stage of SRO delivery the details of the other regulatory consents have not been finalised, preliminary work has been undertaken for the purposes of this Gate 2 submission. This includes the compilation of a list of licences and consents that may be required as part of the solution design, construction, and operational phases of the project.

7.19 Whilst all the physical development associated with the construction and operation of the Interconnector will take place within England, some consents relating to the abstraction of water will be required within Wales and DCO powers cannot be extended to cover these. Therefore, whilst some of the water related consents required within England could be wrapped up into the DCO consent with the EA's agreement, those consents to be granted by NRW within Wales will need to be pursued separate from the DCO process. Subject to further discussion and agreement with the EA and NRW, the intention would be to run this consenting process in parallel with the DCO.

7.20 Further consents and variations would be required as various "supported" sources come online. Each new licence or variation will be the subject of its own scrutiny process and will need to be supported by appropriate environmental, WFD and HRA assessments.

7.21 For future supported flows, the DCO and assessment process will need to map out the operating regime for the Interconnector and the mechanisms through which additional supported flows transmitted by the Interconnector will be assessed and consented. This will include both the need for further planning and other consents and licenses (e.g., abstractions and discharges), as necessary.

7.22 For the Vyrnwy Bypass and Shrewsbury Redeployment only limited 'other' consents are authorised through planning permission and therefore any other consents, such as those relating to land and highways, needed for these elements would need to be sought separately.

Permitting strategy

7.23 At Gate 1 it was agreed in principle with EA and NRW that the support options of STT would operate as a 'put and take' arrangement, where water provided ("put") into the River Severn by the sources during transfer operations can be abstracted ("take") less losses for transfer into the River Thames.

7.24 One of the key consenting issues for the Interconnector is the number of abstraction and discharge permits to be obtained under the Water Resources Act 1991. A permitting roadmap has been developed identifying the necessary variations to existing licences and permits and any new licences and permits that would be required. These are shown in Table 7-4.

7.25 The existing abstraction licences for Vyrnwy, Shelton (Shrewsbury Redeployment) and Mythe will require variation to account for the change in use.

7.26 The new abstraction licence for the Interconnector at Deerhurst may be a transfer licence which would cover transfer of unsupported flow above the River Severn HoF and all future supported flows. This cannot be confirmed until the details of how the interconnector would operate are defined. An abstraction licence may be required if a transfer licence is not appropriate.

7.27 The water transferred from STT to the Thames catchment would be utilised either through the new SESRO licence or through existing Thames Water abstractions from the River Thames. No additional STT specific abstraction licence will be required once in the Thames catchment.

Table 7-4 Potential new licences and permits and variations to existing

	Discharge permits	Abstraction licences
Existing permits / licences to be varied	• Netheridge • Minworth	• Vyrnwy • Shelton • Mythe • River Thames
New permits / licences to be obtained	• Vyrnwy bypass • Netheridge • Minworth* • Interconnector (into River Thames or SESRO)	• Interconnector (transfer licence) • SESRO

*Within the Regional Water Resources Plans Minworth may have 3 discharge locations (existing Tame, new Avon and new GUC). Whether these are 3 separate but linked discharge consents or one consent with 3 discharge points and conditions is to be determined.

7.28 There are four new discharge permits required:

- The potential discharge for STT into the River Thames at Culham .
- A new discharge permit for the Vyrnwy bypass may be required. NRW are to confirm this requirement.
- New discharge permits for Netheridge and Minworth will be required for new discharge points and effluent standards.

7.29 The existing discharge permits for Netheridge and Minworth will need to be varied to account for the new discharge permits at new discharge locations.

7.30 STT SRO has been discussing the permitting requirements of the interconnector with the SESRO SRO. A detailed licencing strategy has been prepared for the River Thames by the SESRO SRO including the discharge permit requirements for the interconnector (into SESRO or the River Thames) and the use of water within the Thames catchment. The detail of the licencing strategy for the Thames is included as part of the SESRO SRO Gate 2 submission.

7.31 NRW has confirmed the maximum release from Lake Vyrnwy permitted under existing Acts and Orders is 405Ml/d. The proposed release direct from Lake Vyrnwy (now reduced to 25Ml/d due to environmental concerns) falls well within this limit. At times when river regulation releases are being made, the STT release would only be possible if the total of regulation releases, compensation releases and STT release did not exceed the maximum. The interpretation of this is that there is no requirement to seek to amend the 1880 Act in order to permit STT. However, a new Section 20 operating agreement under the Water Resources Act 1991will be required to set out the controls and co-ordination of all the elements of the STT system and how it interacts with the River Severn Regulation. The STT partners are continuing to work with the Environment Agency to understand the requirements of this.

7.32 The key features of STT, such as quantities to be released into the River Severn and abstracted at the interconnector, flow related conditions, water quality parameters etc should be set out as far as possible within the relevant permits. The purpose of the operating agreement is to set out the management and operational arrangements of STT; typically, this might include aspects such as arrangements for ramping up / down, interaction with River Severn Regulation, arrangements for other environmental support and communications, common data sharing, and decision making concerning the operation of the SRO. The EA has indicated a Section 20 agreement under the Water Resources Act 1991would be required for the Vyrnwy releases and a separate one for the interconnector.

7.33 An operating agreement will also be required for the utilisation of SRO water from the River Thames or SESRO because of the interaction with the management of the River Thames, the Lower Thames abstractions, and Lower Thames Operating Agreement, which has been managed under a Section 20 agreement since 1989 (originally under Section 125 of the Water Act 1989).

7.34 There would likely be a link between the operating agreements for the STT system and the Thames.

7.35 Given the current uncertainties around the timing of the requirement for STT and the other SROs for the Thames and considering the stage of SRO development, the approach to defining any operating agreements at this stage needs to be flexible.

7.36 The operating strategy for STT is defined only in outline. It is therefore not possible to develop more detail around the requirements of a new Section 20 agreement under the Water Resources Act 1991

for the upstream operation of STT at this point. As ownership and operation of the SRO is developed further, this will enable the Section 20 requirements to be defined. Potential operational benefits offered by STT will need to be explored as part of the Section 20 agreement development.

7.37 There are a number of remaining uncertainties to be addressed as the Permitting Strategy and the STT SRO development continues. These include:

- Current licencing policy is for new licences or varied clauses to be time-limited (but we understand this may change in 2023 when Environmental Permitting Regulations are introduced).
- There are a number of other protected users with licenced abstractions on the River Severn linked to HoF and an approach to these needs to be developed and agreement in principle with the EA sought. The next common end date for the Severn Corridor is March 2034 and this may present an opportunity to consider alternative licence conditions to preserve the STT supported flow for transfer.
- The timing of when to apply for and grant licences and consents if the STT SRO is not selected in regional modelling until 2040 or later (although EA has indicated they have initiated a review of policy to reserve water) and sequencing with DCO.

Land lifecycle

7.38 There will be a need for temporary possession and permanent land acquisition and rights for the STT SRO development, whether secured through negotiation and agreement, or through the use of compulsory acquisition and temporary possession powers under a DCO (in respect of the STT Interconnector) or other existing legislation.

7.39 Land referencing is an essential prerequisite for such land acquisition, establishing the legal interests in land, as the basis for engagement and negotiation. However, given the geographical extent of the STT SRO, land referencing is a significant body of work. It is important to ensure that the detailed work is undertaken at a time sufficiently early to enable information gained to be taken into account in the design evolution and assessment of the SRO. Caution is also required to ensure that it is not so early that the information gained becomes effectively redundant before applications for DCO and other consents are required.

7.40 Reflective of the delivery timescales and current stage of SRO development, it is considered that it remains too early to undertake full land referencing. For the purposes of Gate 2, a high-level land strategy has been prepared to reduce land strategy risks relating to the project, reflect the need for appropriate early land engagement and negotiation where possible to acquire land interests by negotiation and agreement and enable the more detailed land strategy work package to be procured in a timely manner at the most appropriate point in the overall project programme.

Delivering the planning and land acquisition process

7.41 The overall programme for the Interconnector envisages that an application for a DCO would not be made until after the approval of the WRMPs and regional plan, thereby enabling sufficient time for necessary technical and environmental assessments to be undertaken and pre-application engagement held. The summary programme incorporates the planning and land programme for securing a DCO.

7.42 For the Vyrnwy Bypass and Shrewsbury Redeployment, the summary programme shows the earliest start dates that could be achieved based on their consenting through TCPA applications or as permitted development (where EIA is not required).

7.43 Briefing sessions were held with planning stakeholders, including the relevant district, unitary and county local authorities, and the Cotswolds Area of Outstanding Natural Beauty (AONB) Board alongside wider stakeholder consultation. These briefings have provided background context on the purpose of the SRO, the nature of work being undertaken for Gate 2, and the options being considered and developed. A commitment was given to engage on STT beyond Gate 2 and part of that engagement will be to agree the nature and extent of the community and stakeholder consultation as the STT SRO progresses. For the Interconnector DCO, this will include the eventual preparation and publication of a Statement of Community Consultation. Further detail on stakeholder and customer engagement is set out in Section 9.

7.44 There is confidence at this stage that an STT SRO can be developed, assessed, and promoted to successfully secure planning and other consents. From the work undertaken to date, for the purposes of the Gate 2 submission, no insurmountable planning risks to the prospect of securing planning and other consents for STT have been identified. The risks and potential mitigation are proportionate to

what would be expected of a scheme at this stage of its evolution. The risks and issues relating to land and planning and explains how the strategy seeks to manage and mitigate those risks are set out in the Planning, Consents and Land Report Annex.

Key risks and mitigation measures

7.45 Risk assessments have been completed for the STT SRO, and overarching STT system, with the output of these risk assessments reported to RAPID within the quarterly reports.

7.46 Risk is managed across the SRO programme using two specific approaches:

- A Costed Risk Register which is produced by the technical workstreams. This follows the standard ACWG Cost Consistency Methodology and provides the detailed breakdown of technical and construction phase risks that could have a material impact on the costs of the SRO.
- The overarching Programme Risk Register, as reported at high level to RAPID through the quarterly reporting process. This provides a register of programme-level risks to the overall delivery of the SRO. It includes risks associated with the STT system where these would not otherwise be dealt with at a SRO level.

7.47 The output of risk assessments completed for the source support elements are reported under the separate United Utilities and Severn Trent Water SRO reports. Costed risks were incorporated into the source support element indicative prices offered by United Utilities and Severn Trent Water. These prices were inputted into the regional modelling and reflected with the STT SRO costs in the overall STT cost breakdowns.

7.48 The STT programme risk register has been maintained and reviewed with STT partners to review and update the mitigation strategy, identify new and emerging strategies, and highlight key risks to be reported to the regulator.

7.49 The key overarching programme risks, as presented in the RAPID quarterly report, are summarised in Table 7-5.

Proposed Gate 3 activities and outcomes

7.50 Figure 7-2 illustrates the indicative overall timeline and activities post-Gate 2 for the interconnector development.

7.51 The RAPID guidance for Gate 2 sets out that: ‘By gate three, solution owners should have narrowed down their solution to a firm single, potentially scalable, option including location as included in final regional plans and WRMPs. This means that pre-planning application consultation should have been completed.’ We believe that, to achieve this, we will require two stages of non-statutory consultation and a circa 2.5-year period for Gate 3. Note, we have not included statutory consultation in Gate 3.

STT Mid-Gate3 Checkpoint

7.52 However, it should be noted that, unlike Gates 1 and 2, the timing of Gates 3 and 4 can only be indicative at this stage as they are tied to the planning and consenting process, including consultation, and therefore durations may vary depending on the feedback received.

7.53 We propose to introduce a ‘Mid-Gate3 Checkpoint’ at the end of 2023 to:

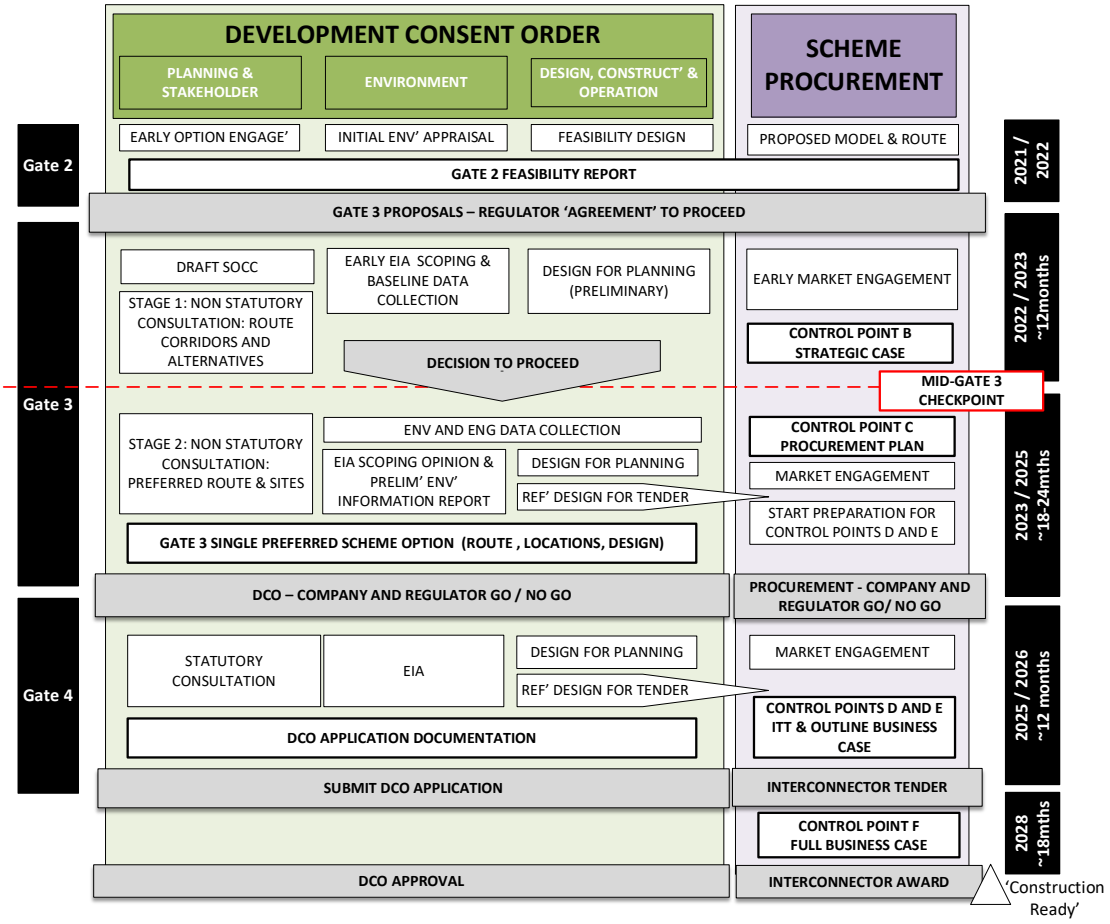
- decide if STT needs to proceed beyond 2023 and if so at what pace. This will be informed by:
    - the approved final regional and WRMP24 plans
    - any regulator input into the requirement to progress the SRO
- allow any adjustment in project scope (e.g., bypass), partner participation and funding requirements
- ensure value, avoiding the progression of solution too early which could lead to abortive work and inefficient expenditure.

7.54 Until the Mid-Gate3 Checkpoint we would propose to continue to work at pace to achieve construction ready status in AMP 8, if required.

Table 7-5: STT Selected Key Programme Delivery Risks

Reference	Short description name / trend	Pre-mitigation Impact	Detailed description including plan to manage (in just a few sentences)	Post-mitigation impact
RSK001	**Challenges and objections from stakeholders.** **Trend: Stable**	Amber	Risk: Potential challenges and objections to the SRO proposals from stakeholders in England and Wales. Includes potentially affected landowners, communities, interest groups, local authorities, and other statutory consultees Mitigation: Implement engagement plans to ensure stakeholders are appropriately briefed and that we understand and address their concerns as far as is reasonable for Gate 2, with further actions identified for Gate 3. Co-ordinate STT plans with companies and regional groups to ensure joined-up engagement activities and consistent messaging. Engagement to include Welsh stakeholders and the requirements of the Wellbeing of Future Generations (Wales) Act 2015. Recognise that as the SRO develops new issues will emerge and our engagement with stakeholders will increase with a robust process to be adopted to as part of pre-application consenting processes. To avoid unnecessary concerns and distress, engagement with potentially affected landowners will only be undertaken at Gate 3, starting with route corridors and only if the SRO is selected to proceed for early (2040) delivery.	Amber
RSK002	**Alterations to River Severn regulations and development of STT permitting strategy** **Trend: Decreasing**	Amber	Risk: Understanding and agreeing how STT unsupported and supported flows are permitted to secure both the transfer of STT flows and the integrity of existing and future Severn Regulation River and the rights of other abstractors. Risk relates to SRO operation with rivers upstream and downstream of the interconnector. Particular risk identified at Gate 1 regarding the need or otherwise to amend the Acts governing River Severn relation from Lake Vyrnwy and Clywedog. Mitigation: For Gate 2 develop a “permitting roadmap” for the STT operation with river regulation, licensing, associated abstraction charges and any changes required to it as a consequence of STT. Further development of permitting requirements including the technical detail of the permit requirements would be developed for Gate 3. Amendment to 1880 Act of Parliament now appears unlikely to be required.	Green
RSK003	**Commercial operation & procurement strategy development.** **Trend: Stable**	Amber	Risk: The commercial operating between providers and users of the transferred water and the asset ownership model for STT is complex. A clear and feasible commercial strategy that is acceptable to companies and regulators needs to be developed ahead of Gate 3 to mitigate the risk of programme delay and to verify a feasible commercial model(s). Mitigation: Procurement of a commercial advisor at Gate 2 to facilitate development of a commercial strategy with the companies and the regulator. The commercial strategy identifies potential SRO “promoter”, asset ownership, procurement route (e.g., DPC) and commercial operating models with further development of this required for Gate 3.	Green
RSK006	**Regional/WRMP/RAPID interface – decision-making for Gate 3 SROs** **Trend: Stable**	Red	Risk: The process and timing of decision-making between regional water resource groups, the WRMPs and RAPID and the information that it is based on needs to be aligned with a clear process that provides clarity of information and decision making for all parties, avoiding delays, stakeholder challenges and abortive work. Proceeding into Gate 3 is a significant step for the project which will require significant effort to plan and implement, with a new supply chain procurements and potentially a change in partner funding and responsibilities. Preparations for Gate 3 commencement in November 2022 are a critical path activity. Understanding how and when decisions are made by the regulator and the relationship with the finalisation of WRMP24 plans is critical to the preparations for Gate 3. Particularly the nature of RAPID's review at Gate 2 and how and when SROs may proceed into Gate 3. This may include strategies to de-risk SRO delivery and water resilience impacts by progressing multiple SROs Mitigation: Engagement is ongoing between the RAPID and STT to understand expectations for starting Gate 3 and process by which it will be managed. The STT SRO is similarly working with regional groups and companies to ensure co-ordination of information and highlight any differences. A “Mid-Gate3 Checkpoint” is proposed at the end of 2023 to ensure the development of STT is aligned with the requirements of the regional plan and RAPID. An update to regional plans to reflect any material changes in the STT proposals at Gate 2 may be required in the WRSE 2023 upload.	Green
RSK009	**Compliance with the Habitat Directive Regulation Assessment (HRA) for the Severn Estuary** **Trend: Decreasing**	Red	Risk: Compliance risk associated with the Habitats Directive Regulation Assessment (HRA) for the Severn Estuary SAC including linked habitat (inc. Teme, Clun, Wye, Usk etc.). Mitigation: For Gate 2, an “informal” HRA assessment is required allowing for identification of uncertainties and further assessment. However, evidence “beyond all reasonable (scientific) doubt” may be required for regional plans and WRMPs. This may affect permissible direct releases into the River Vyrnwy, the treatment and/or use of Minworth treated effluent. We are engaging with regulators to work through this issue and the evidence base that would be required to demonstrate that the integrity of the estuary SAC is not compromised by the STT with the conclusions of our assessment and further work required are reported in the Gate 2 documentation.	Green
RSK012	**Emerging chemicals** **Trend: Stable**	Green	Risk: A definitive approach from the risk of water quality “emerging substances” is required to ensure proposals for Gate 2 and future monitoring and assessment is developed appropriately and consistently across SROs. Uncertainty in sampling requirements may result in impacts to the gated programme and SRO development. Mitigation: The SROs have proposed a “watching brief” where sampling and investigations are maintained as currently agreed, but there is flexibility to amend this in the future based on any updated industry published guidance. We have added additional sampling to the STT monitoring regime during Gate 2 based on current industry guidance. For Gate 2 the risk has been mitigated by agreeing the sampling approach and requirements with the regulators and fixing sampling requirements based on industry guidance available at the start of Gate 2. Flexibility would be introduced at the start of future gates if industry guidance changes.	Green
RSK017	**Risk to River Vyrnwy direct release** **Trend: Increasing**	Amber	Risk: Demonstrating HRA and WFD compliance in relation to Lake Vyrnwy River regulation releases in combination with STT support may affect the extent or viability of direct releases into the River Vyrnwy. Furthermore, eDNA results from summer 2021 and autumn 21 surveys show target sequences for protected freshwater pearl mussel (FPM) and depressed river mussel (DRM). The size of direct releases will affect the capacity and discharge location of the bypass pipeline and therefore the cost effectiveness of the North West Transfer supply. Mitigation: Investigations, modelling, and assessments to determine the limit on releases into the River Vyrnwy for reporting in Gate 2. Undertake further surveys in spring 2023 to confirm viability or otherwise of mussel populations. These mitigations should address the risk and determine the appropriate level of direct release.	Green

Figure 7-2 Overview of Interconnector post Gate 2 activities



7.55 The Mid-Gate 3 Checkpoint should not be viewed as "mini regulatory gate submission" but rather as a short governance process between RAPID and the STT partners to make any formal adjustments required to the direction and working arrangements of the SRO.

7.56 The Project Delivery Plan Annex includes further breakdown of the proposed Gate 3 activities.

Gate 3 structure

7.57 Maintaining participation and collaboration between the principal donor and recipient companies is considered fundamental to the successful integration and development of STT source and transfer assets in order to form an efficient and operable STT system.

7.58 The Gate 2 commercial workstream has also identified that the promoter of the Interconnector would be Thames Water. At Gate 3 the SRO will embark on the start of the Interconnector DCO pre-application phase. It is important from the start of Gate 3 that there is clarity internally, with the regulators and with external stakeholders on Thames Water's responsibilities, accountabilities, and funding in respect of the Interconnector development.

7.59 Also, through the Gate 1 and Gate 2 STT SRO development, the requirement for the River Vyrnwy bypass pipeline has been confirmed. With limited acceptable direct discharge to the River Vyrnwy, the bypass is now intrinsic to the provision of support water from Lake Vyrnwy.

7.60 Since PR19 the project development phase has extended and the scope increased, including the need for the bypass which was not included in the PR19 SRO funding. So, whilst the STT SRO has developed within budget through Gates 1 and 2, additional funding is needed to meet the development requirements of taking this complex, linear project through the DCO and DPC process for Gates 3 and 4. This is discussed further in Chapter 11.

7.61 Shrewsbury stands alongside the Bypass as a separately supplied source also via the North West Transfer SRO from Oswestry, similar to the Bypass. It is logical and efficient for Shrewsbury and the Bypass development to remain linked.

7.62 An STT SRO model for Gate 3 is therefore required that provides:

- joint co-ordination and integration of STT system activities,
- separate accountability and authority to Thames Water to develop the Interconnector,
- separate consideration to the Bypass and Shrewsbury which are intrinsically linked to the North West Transfer SRO and can supply Water Resources West companies

7.63 To address these requirements, it is proposed to divide the STT SRO into three components:

- System Co-ordination
- Interconnector Development
- Bypass and Shrewsbury

7.64 Figure 7-3 illustrates the STT SRO with these three components alongside the other STT source SROs.

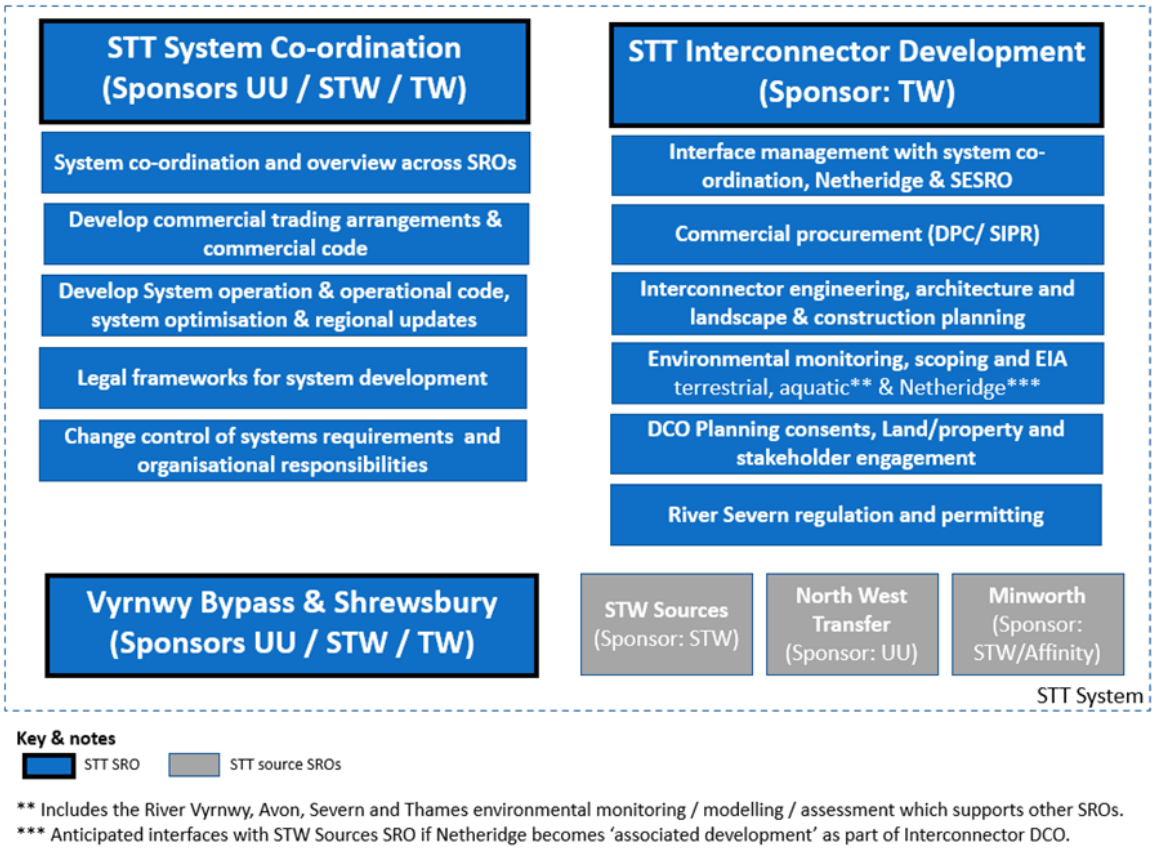


Figure 7-3: Proposed Gate 3 STT SRO structure

Procurement, ownership, and operation

7.65 Building on the Gate 1 submission, the Gate 2 process has concluded that the STT System is not considered to be suitable as a DPC in its entirety. However, we have considered separately the two largest elements, by capital value, for suitability for procurement using DPC.

The Interconnector

7.66 The Interconnector is seen as an element of the STT SRO which is suitable for a DPC. The reasons why this conclusion has been reached are as follows:

- Size of Project – The expected Capital costs of the Interconnector are likely to be substantially greater than the de minimis threshold of £100m (and £200m as set out in PR24 Draft Methodology) for a project to be considered a DPC. Noting the threshold is exceeded by CAPEX alone and before any consideration of potential OPEX expenditure.

- The development and function of the Interconnector is entirely separable from the operation of the wider Thames Water network. As a discrete element the provision and operation of the asset can be separately contracted for and incentives specific to the Interconnector put in place through that contract.
- There is evidence that the provision of underground assets as part of a wider system but operated independently of that system is attractive to market participants, in particular construction parties and investors in the DPC arrangements.

7.67 Although based on these considerations a DPC procurement would appear to offer value to customers, a comprehensive value for money assessment of DPC vs BaU procurement for the Interconnector will be undertaken at the DPC Control Point E, in accordance with Ofwat guidance.

7.68 Thames Water are considered the party who would take forward the delivery of the Interconnector as the Appointee and contract with a CAP accordingly. The rationale for Thames Water as promoter of the DPC is based upon:

- That DPC is currently constructed on the premise that there would be a single Licence holder for the design, build, finance, and operation/maintenance contract that underpins DPC and at the end of the concession period the asset may revert to that Licence holder for a defined payment.
- The primary beneficiaries of the Interconnector function are expected, in the first instance to be Thames Water customers, it is recognised however that other beneficiaries of the STT System may become apparent as the System develops and so we have considered in the commercial terms under which the Interconnector activities could be funded by other customers in the future.
- To put in place multiple promoters of the Interconnector function implies a fractional ownership of the underlying asset. A fractional ownership model may introduce negative views from investors in the DPC on the grounds that there is very little precedent for such an arrangement and it leads to significant additional complexity and counter party risks. It also represents a change in asset models applied in current regulatory arrangements.

Vyrnwy Bypass Pipeline

7.69 Based upon the current estimates of the cost of this element of the STT system we have concluded that the project is unlikely to offer enhanced value for money to customers if it were to be procured under DPC arrangements. This is particularly the case if the PR24 Methodology limits of £200m TOTEX were to be applied. However, the costs will necessarily be kept under review and a formal comparison of Value for Money should be made when SRO specification is further developed.

7.70 The party best placed to promote the Vyrnwy Bypass pipeline depends to a significant degree upon the estimates of who the ultimate beneficiaries of the bypass utilisation may be. The initial beneficiaries of the project may be Severn Trent Water customers and as such, applying a similar argument for the promoter of the Interconnector, Severn Trent Water would be best placed to be the party responsible for the delivery of the asset. Should circumstances change and the Bypass be used primarily to enable water to be supplied to the Thames Water area and beyond, then Severn Trent Water may seek to enter into a contract with Thames Water to enable the investment costs of the bypass to be recovered under the action of the STT system code.

7.71 The development of all other infrastructure / assets to complete the STT System outside of the Interconnector and Vyrnwy bypass pipeline would be delivered by each party in their relevant geography. These are addressed in their own individual SRO submissions.

Other considerations

7.72 The use of a “licensing model” or Special Infrastructure Projects Regime (SIPR), like that of the Thames Tideway Tunnel, has also been considered for the development of the Interconnector. To meet the legislative requirements of SIPR as set out by the Secretary of State, the project would need to have the following impact upon the Appointee:

“The project is of sufficient scale and complexity to put at risk continued operations.”

7.73 This is considered unlikely under the current legislation given:

- The project size is unlikely to be material relative to the existing Regulatory Capital Value of Thames Water. For example, the STT SRO capital costs represent c9% of the current Regulatory Capital Value of Thames Water. This compares to Thames Tideway Tunnel where CAPEX costs represented c50% of the prevailing Regulatory Capital Value.
- The engineering solution is not especially novel or complex.

7.74 On this basis, SIPR has been assumed not to apply to the interconnector procurement, and DPC is therefore the assumption from Gate 3. However, it is noted that STT is a large SRO that has been identified by Ministers as potentially able to benefit from a revised SIPR, and that Ofwat have recommended to Government that the legislative tests be broadened to remove the 'size and complexity' test. A procurement of the interconnector under SIPR may therefore be considered should this change progress, subject to timing of the project and legislative change.

7.75 In line with DPC guidance documentation, possible tender models for the development of DPC projects are an Early, Late, Very Late or Split procurement model.

7.76 Considering the development of STT Interconnector with its interfaces and reliance on the wider STT system, the “Late” model is currently considered to be the tender model most suited to the project. The model allows the Appointee to take the project through to planning/consent while also engaging the market early enough (before detailed design) to allow for innovation from the CAP in the Design Phase as well as a manageable risk profile for both the Appointee and the CAP during the development of the project. The other tender models have been discounted based on the following factors:

- The Early model has been discounted as the Appointee will develop the project up to planning/consent in line with existing programme development expectations.
- The Very Late model is discounted as it excludes the CAP from the Detailed Design phase which limits opportunities for innovation from the CAP and changes the risk profile.
- The Split model is discounted given the time impacts and cost of multiple tender rounds as well as potential reduced market engagement given the extent of tendering, while also limiting the Appointee’s ability to take the project to control the process up to and including planning/consent.

7.77 The choice of procurement procedure is yet to be determined; however, potential options will be considered in line with the parameters of the Utilities Contracts Regulations 2016, including Open, Restricted, and Negotiated procedures with a prior call for competition. The innovation partnership is not considered appropriate for this project and the products and services are deemed available in the market given the nature of the infrastructure requirements.

7.78 Running a separate procurement process for the construction element of the Interconnector and the financing elements remains under consideration. This will be further developed once the project progresses through to Gate 3 and can be considered in the detailed procurement strategy of the party taking the Interconnector project forward.

7.79 As illustrated in Figure 7-1, a high-level project development timeline aligning the RAPID Gateways and Ofwat Control Points as well as key project development elements has been compiled.

7.80 The development of these plans supports the wider STT system planning and programme management. It does so by highlighting the timeframe of the Interconnector and therefore the need to ensure alignment with other infrastructure and assets required for the STT system to work in its entirety. Further work around the sequencing and commitment to elements of the system by all partners involved is required at Gate 3.

7.81 The current programme also assumes a parallel Procurement and DCO application process; this helps to reduce overall programme length to achieve contract award dates but is noted as a process which needs to be managed given the volume of activity through DCO decision, Full Business Case approval and subsequent Contract Award and Financial Close.

7.82 As part of the Gate 2 process, a number of commercial models have been considered to manage the contractual relationships of the STT system, to establish how costs and revenue would flow and ultimately how the system would be managed. Further details are provided in the Procurement, Ownership, and Commercial Operation Report Annex. In summary three models were considered: Joint Venture Model, Buyer Seller Model, and System Operator Model.

7.83 The Buyer Seller model as illustrated in Figure 7-7 is currently considered the basis of the commercial model; however, it is subject to change and further development in line with ongoing discussions amongst the participant parties. Key principles of the commercial model include:

- Buyers are any party who seeks to purchase water and resilience from all or some of the STT system
- Sellers are parties that have the ability to provide water to the STT System

- Infrastructure providers are parties that have funded new assets to convey water through the STT system e.g., the Interconnector and potentially the Vyrnwy Bypass Owner/Operator

7.84 Thames Water would develop and procure the Interconnector, determine what supply is required in its area, instruct the Interconnector operator and abstract water, accordingly, ordering water gross of expected losses. The CAP contract will encompass Design, Build, Finance, and Operate obligations.

7.85 The Vyrnwy Bypass Assets may also result in charge to buyers on a usage and availability basis. This is irrespective of the procurement model put in place to deliver the Bypass assets.

7.86 Thames Water would recover its costs via customer charges through water bills and pay for charges from the Interconnector operator as well as from sellers (i.e., Severn Trent Water and United Utilities) for the provision of supply availability as well as consumption reconciled on an annual basis.

7.87 Severn Trent and United Utilities would invest in necessary infrastructure at sources to support the STT system. They would maintain these assets accordingly and provide water in line with supply agreements.

7.88 Costs for sellers would be recovered relative to consumption through volumetric charges, or where assets are provided, on an availability basis.

7.89 Taking the principles of the Buyer Seller Model in Figure 7-4 the following model has been developed and tailored to the STT structure and is currently termed the “The Extended Simple Model.” This model involves creating commercial arrangements to all parties who, at the outset of the STT system implementation can be identified as potential beneficiaries. This can be shown in the following structure:

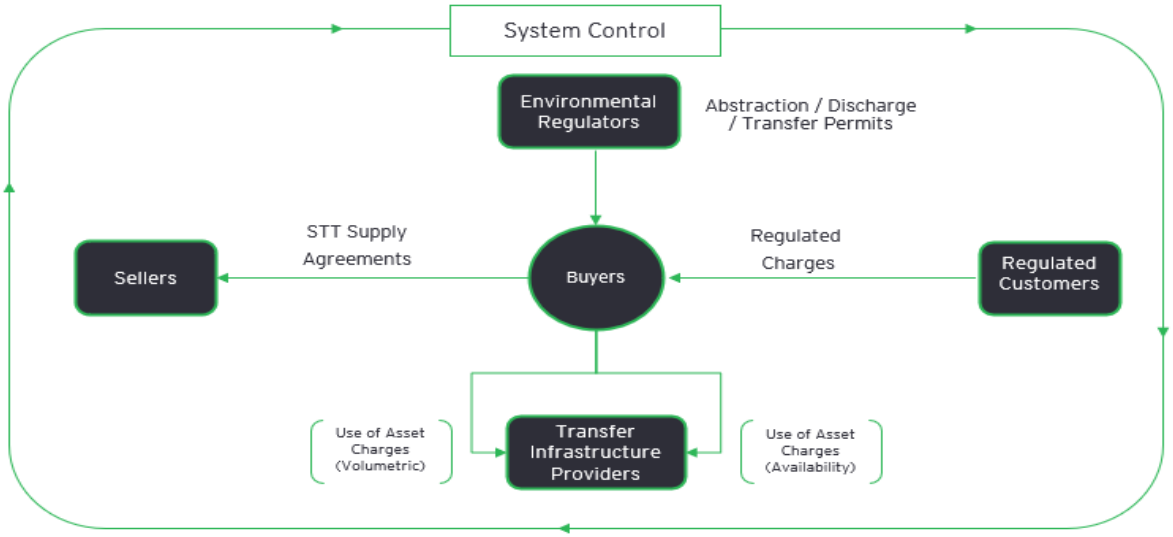


Figure 7-4 Indicative commercial model

7.90 In this model all parties who may seek additional water to be provided by the STT System will enter into Bulk Supply Agreements with the two potential providers of that water. While it is the case that South East Water users may seek additional supplies from Thames Water with its own resources, that is excluded from the STT System as is water already present in the Southeast region.

7.91 This “Extended Simple Model” is currently considered to be the preferred approach however, stakeholders will continue to work and develop this approach as the project progresses through the RAPID Gateways.

7.92 The model shown in Fig 7-5 reflects, in the dotted orange lines, the potential for the CAP to receive pumping instructions from parties other than Thames Water who would be the main contract counterparty of the DPC. This charging regime would be governed by the Code described below.

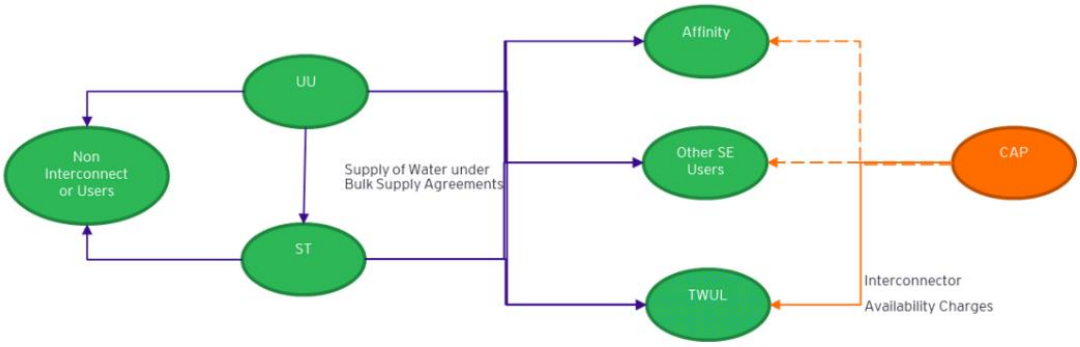


Figure 7-5 Extended Simple Model

Code / Supply Agreements / System Control

7.93 The full extent of Charges is currently being further developed and will build on the principles of the model above in order to provide a commercial solution for the STT System. This will coincide with the development of a Code to align the water companies involved in STT as well as the agreement of Supply Agreements for the provision of water in the system. Current thinking will see the principles of Bulk Supply Agreements used as the basis that structure. The Code should set out arrangements for cost allocation, charging principles and the need to demonstrate commercial neutrality.

7.94 A System Control function is also being considered to ensure that the system remains within the environmental and operational parameters and that all requests for supply volumes are accounted for in terms of pricing and allocation of costs. Determining the availability of river systems for transfers should remain the responsibility of Environmental regulators through newly established or modified abstraction, discharge and transfer permits for STT. The System control function should ensure fair allocations of water are made across the STT system. The system control and operation philosophy will be explored further in Gate 3 with steering groups established to address communication protocols, trading, responsibilities, hand-offs etc

7.95 Key risks which have been highlighted from the current commercial thinking include the sequencing and commitment of each party to deliver infrastructure for the STT System so that asset investment is well timed, efficiently used, and costs recovered accordingly. In addition, the need for a commercial model which is adaptable for future resilience / change e.g., future additional participants are also being developed as the SRO progresses.

7.96 Market engagement has been incorporated into the project development timeline. To date, no market engagement has taken place, given the early stage of the project and the need for clarity over the definition of the system which has taken place since Gate 1. From Gate 2 to onwards market engagement will be key to testing key assumptions around the development of both the Interconnector and wider STT system.

8 Solution costs and benefits

Solution cost estimates

8.1 Capital Expenditure (CAPEX) and Operational Expenditure (OPEX) for the River Vyrnwy Bypass Pipeline, Shrewsbury Redeployment and Interconnector are presented in this SRO. Costs for Netheridge and Mythe are covered in the Severn Trent Sources SRO and Minworth costs are detailed in the Minworth SRO. Costs of the additional works to facilitate the Vyrnwy transfer are detailed in North West Transfer (NWT) SRO.

8.2 CAPEX costs were generated using United Utilities, Thames Water and Severn Trent Water cost databases for the River Vyrnwy Bypass Pipeline, Interconnector and Shrewsbury Redeployment respectively. The approach to CAPEX costing used at Gate 2 was consistent with the approach used at Gate 1 and PR19. Costs were produced in accordance with the ACWG Cost Consistency Methodology Revision E, issued February 2022. Outline designs have been developed and costed

using company costs where available, or industry costs for items such as the large pipelines. All costs are presented at 2020/21 prices.

8.3 Optimism bias (unknown unknowns) was calculated in conjunction with a Quantitative Risk Analysis as detailed in the ACWG Cost Consistency Methodology, resulting in a scaled-back optimism bias figure. Known unknowns have been identified in the costed risk register and include allocations for ground conditions, land agreements and planning requirements. Risks are quantified and allocated minimum and maximum expected budgets, and the probability of that risk occurring is assessed. Risk costs can be linked to delays to construction activities and the impact can be estimated using previous experience. Some costed risk items have been reallocated to optimism bias due to the unknown nature of the risk. This includes material price volatility which is difficult to quantify at present. The Interconnector options have been redefined as Non-Standard for this Gate 2 submission (due to the large diameters of the pipelines proposed) in accordance with the guidance provided by the ACWG. This has increased the optimism bias percentage applied, but with the removal of some of the costed risk items, the overall total risk allocation remains broadly unchanged in value from the Gate 1 submission.

8.4 OPEX costs were generated for each option. OPEX includes labour, power, chemicals, and an allowance for operational maintenance. OPEX costs are presented with a fixed and variable component. Fixed OPEX relates to staffing and maintenance work which is required to operate the system for all flows and the variable OPEX relates to power and chemical usage. OPEX has been calculated using the minimal operational regime and also for maximum capacity for comparison. Changes from Gate 1 and the WRSE draft regional plan submissions are covered in more detail in the Cost Report Annex. We note that the current high costs for power have not been incorporated in the variable calculations and rates will be reviewed at Gate 3 across all options. A significant increase in electricity will not affect the optioneering presented here but it may affect the WRSE draft regional modelling undertaken. This will be reviewed in Gate 3. CAPEX and OPEX are summarised in Table 8-1.

8.5 For the Interconnector options, there have been a number of minor changes to the pipeline option as it has developed during Gate 2. Additional water quality sampling has resulted in changes to the WTW design and also chemical usage. CAPEX costs remain broadly similar to Gate 1 figures and the numbers submitted for the WRSE draft regional plan. The biggest changes are due the reduction in pipe sizes, the reduction of size of the break pressure tank and the removal of the need for an intake tunnel between the river intake and the low lift pumping station. There have been some changes to the costed risk and Optimism Bias allocations but risk budgets remain similar to the previous submissions. There has been a small increase in fixed OPEX from the Gate 1 and WRSE Draft Regional Plan submission to Gate 2. Interconnector minimum OPEX has dropped for the 400Ml/d and 500Ml/d options due to a decrease in the minimum sweetening flow rates (reduced from 10% to 20 Ml/d).

Table 8-1 CAPEX and OPEX for each option (2020/21 base date)

Option Name	Units	Deerhurst Pipeline – 500Ml/d	Vyrnwy Bypass
Option Benefit	Ml/d	490	150
CAPEX			
Base CAPEX	£m	909.1	143.2
Costed Risk	£m	25.7	13.3
Optimism Bias	£m	335.0	42.1
Total G2 CAPEX	£m	1269.8	198.5
Total G1 CAPEX	£m	1222.8	154.3*
Change G1 to G2	%	3.8%	28.7%
OPEX			
G2 Fixed	£m/ annum	3.84	0.21
G2 Variable	£/Ml	187.1	0.00
G1 Fixed	£m/ annum	2.94	0.14
G1 Variable	£/Ml	178.8	0.01
Change (Min Flow)	%	-15%	n/a

** Gate 1 included several options. The figure shown here is the option of comparable length and flow.*

8.6 Vyrnwy Bypass costs have increased from Gate 1 and the WRSE Draft Regional Plan. This is mainly due to a change in the preferred option which now requires a longer route and larger pipe due to increased flows. The preferred option at Gate 1 required a pipeline to convey 80Ml/d to the River Vyrnwy and this increased to 105Ml/d for the WRSE Draft Regional Plan submission. The preferred option at Gate 2 requires a pipeline to convey 150Ml/d to the River Severn. Costs have also increased due to the identification of poor ground conditions which require additional trench support, as well as additional environmental mitigations. Further development of the route has resulted in increases to the average depth of pipe and the number of trenchless crossings has more than doubled. These elements have resulted in a significant increase to the direct works cost. OPEX has increased slightly as the operational maintenance is linked to the capital value of the SRO. All OPEX costs are classified as fixed i.e. they do not vary with flows in the pipe.

8.7 Shrewsbury Redeployment costs were presented at Gate 1 as £/Ml only and therefore comparison with Gate 2 is not possible.

8.8 Construction CAPEX and OPEX costs have been used to generate the net present value (NPV) values for the elements, using the Treasury Green Book, with a declining schedule of discount rates (Annex 6, Table 8) and an 80-year period. Each option is composed of many elements with varying design lives which range from four years to 250 years. Assets with a shorter life will require ongoing replacement over the life of the SRO and these replacement costs are used in the determination of NPV. The estimated NPV and average incremental cost (AIC) for each of the options are shown in Table 8-2. AIC is presented for the minimum and maximum flows for each of the options. There are many potential operating regimes for the system but for consistency of presentation the minimum and maximum flows have been used in the calculation.

Best value and solution benefits

8.9 A ‘Best Value’ water resource plan is one that delivers wider benefits to society and the environment. It considers a range of factors alongside economic cost in the identification of the preferred water resource programme that will form the basis of the plan. The development of a best value plan is promoted by the EA, Ofwat and Natural Resources Wales in the Water Resources Planning Guideline.

8.10 WRSE is carrying out best value analysis to develop the Best Value Regional Plan. The Thames Water WRMP is cascaded from and fully aligned with the WRSE Regional Plan, and so the same best value metrics have been considered in both plans.

8.11 Best value metrics have been determined for the SRO scheme. The metrics considered in addition to cost and carbon emissions are Natural Capital (NC), Biodiversity Net Gain (BNG), SEA benefit, SEA disbenefit, resilience: reliability, evolvability and adaptability, and customer preference.

8.12 The methodology for the metrics utilised at a regional level, consistent with the draft WRMPs and STT SRO, is provided in Annex 1, Part 3 of the WRSE draft Regional Plan. A summary of the best value metrics utilised for STT is included within Thames Water’s draft WRMP, alongside other SROs and non-SROs for context.

8.13 The draft WRSE regional plan shows:

- In the reported pathway of the preferred plan, the STT 500 Ml/d variant is selected to transfer water from 2050 onwards, initially with support from Netheridge, and then with further support subsequently provided by both Vyrnwy (brought online 2053-55) and Minworth (2060).
- The STT also features in pathway 1 of the WRSE regional plan, again from 2050 onwards. Further details can be found in Sections 10 and 11 of the Thames Water WRMP.

8.14 The philosophy of Best Value has been embedded in the decision making of the elements that make up the STT SRO. Factors alongside economic cost have been considered in determining the preferred interconnector option, bypass route and system optimisation. These factors have included environmental impacts, environmental metrics, resilience metrics, societal benefits, adaptive futures and carbon. These considerations are detailed in this report and the associated Annexes. We are confident the Best Value has been achieved within the STT SRO.

8.15 Once the STT SRO proposal established its best value solution, information has been provided to the WRSE to enable modelling of the various scenarios and establishment of a Best Value Plan for the Region. To assist in that decision making, a variety of data sets were provided by the STT team. These included

CAPEX, OPEX, carbon, environmental metrics, resilience metrics, earliest availability timelines and phasing of sources. This information has allowed the WRSE and WRW to appraise the STT alongside different SRO's, undertake engagement, consider adaptive planning approaches, and justify their preferred Best Value Plans.

Table 8-2 Net Present Value and Average Incremental Cost (Standard Discount Rate) (2020/21 prices)

Option name	Units	Deerhurst Pipeline 500Ml/d	Vyrnwy Bypass
Option benefit (max flow)	Ml/d	490	180
Min flow (Gate 2)	Ml/d	20	0
Min flow (Gate 1)	Ml/d	50	0
Total planning period option benefit (NPV)	Ml	3,442,617	1,626,968
Total planning period indicative capital cost of option (CAPEX NPV)	£m	1009.1	166.8
Total planning period indicative operating cost of option (OPEX NPV)	£m	100.3	5.1
Total planning period indicative option cost (NPV)	£m	1109.4	171.9
G2 Average Incremental Cost (AIC)	p/m³	32.2	10.6
Gate 1 AIC	p/m³	32	n/a
Total planning period indicative operating cost of option (OPEX NPV)	£m	718	5.1
Total planning period indicative option cost (NPV)	£m	1727.3	171.9
G2 Average Incremental Cost (AIC)	p/m³	50.2	10.6
G1 AIC	p/m³	48.1	n/a

STT system costs

8.16 In order for the STT system to be fully operational, there are additional costs associated with the various sources. These costs are detailed in the other SROs but are summarised in Table 8-3.

Table 8-3 STT source CAPEX and OPEX costs (2020/2021 base date)

Option name	Max Flow (Ml/d)	Total G2 Capex (£m)	G2 fixed Opex (£m/ annum)	G2 variable Opex (£/Ml)
Mythe	15	n/a	n/a	n/a
Netheridge	35	139.1	0.8	212.6
Minworth	115	244.7	1.5	387.0
NWT	205	852.5	1.6	81.2

9 Stakeholder and customer engagement

Introduction

9.1 This section provides an overview of the engagement undertaken with stakeholders and customers, providing a summary of the main feedback points, and how these have been considered in the work undertaken and the development of the SRO. It also sets out issues that need further investigation.

9.2 The engagement programme built on the work completed in Gate 1 and took account of the stakeholder representations to RAPID on Gate 1 as well as direct feedback from RAPID, other regulators and stakeholders. Our engagement approach through Gate 2 was threefold:

- Support WRSE, WRW and the water companies on their engagement as part of the work to prepare regional plans and WRMPs and use the opportunity to introduce the project to interested stakeholders and gain their feedback to reflect and update our plans.
- Carry out technical engagement with regulators.
- Undertake targeted engagement with stakeholders, including local authorities and interest groups, identified in our updated stakeholder plan.

9.3 The feedback from stakeholders on STT from the WRSE and WRW Emerging Regional Plan consultations has been mainly positive.

9.4 For the WRSE Emerging Regional Plan consultation, approximately 1,150 written responses were received, with STT being the option that received the second-highest number of individual responses.

Approximately 300 responses expressed support for the restoration and use of the Cotswold Canals to transfer the water from the River Severn catchment to the River Thames catchment.[13]

9.5 WRW held a series of workshops with stakeholders from the region, including a workshop discussion on water transfers. There was support for sharing water resources, with 75% of workshop stakeholders agreeing or strongly agreeing with the proposal, recognising the need to work together to tackle this problem. However, this was a divisive issue. Some stakeholders objected to their water-rich region losing out to developments in the South, whereas others agreed that water transfer was ethically the right thing to do.

9.6 Our STT technical engagement was embedded throughout Gate 2 SRO development, through presentations, workshops and 1-2-1 sessions with regulators and stakeholders. These included RAPID, EA, NE, NRW and DWI. In the Autumn of 2021, we held individual workshops with regulators on the following topics:

- Habitats Regulations Assessment
- Biodiversity Net Gain / Natural Capital Assessment / Sustainable Management of Natural Resources
- Water Framework Directive
- Strategic Environmental Assessment

9.7 Working with SRO teams from Severn Trent, Thames Water and United Utilities, the STT team led on the engagement with regulators to resolve environmental issues.

9.8 These included the preparation of technical notes and discussions on the following topics:

- SEA methodology
- Cumulative effects methodology
- Water quality (emerging chemicals) guidance

9.9 We also engaged with stakeholders who had strategic and technical knowledge and information on the SRO operation. We held informal 1-2-1 meetings to share information at timely intervals and sought their feedback to the ongoing SRO appraisal and development.

9.10 We have engaged with stakeholders from Wales throughout Gate 2 and will accelerate this engagement further in Gate 3. Regular updates were provided to Welsh Government officers through ongoing engagement by WRW, supported by the 3 water companies and the STT project team. Meetings were held with representatives from NRW as part of wider technical engagement with environmental regulators. Briefings were provided on STT to Welsh local government through the WRW and water company WRMP pre consultation engagement and Powys Council officers were invited to and attended a project introductory briefing on the 13 July 2022. STT and WRW representatives introduced the project to the Wales Water Management (WWM) Forum on the 12 May 2022. The WWM Forum is made of representatives from a range of organisations interested in the Welsh water environment, including Welsh Government, Public Health Wales, NFU Cymru and Wales Local Government Association.

9.11 During June and July 2022, we held introductory sessions with environmental stakeholder groups, river interest groups and local authority officers. The aims of these sessions were to introduce the SRO, provide an overview of the relationship with regional water resource plans and WRMPs and to highlight our project programme. We also set out to explain our preferred Interconnector options and summarise the key project issues and opportunities. We asked how stakeholders would wish to be engaged going forward and sought feedback on key themes to consider for Gate 3.

9.12 Landowners, local residents, businesses and other affected stakeholders along the proposed Interconnector corridors will be introduced to the project ahead of the ‘Mid-Gate3 Checkpoint’. This will include engagement on the Interconnector corridors and alternatives considered. Post Mid-Gate3 Checkpoint, if the project features in the final WRMP and is selected to proceed, we will undertake engagement on the details of the preferred Interconnector route and consultation in accordance with the Planning Act 2008 pre application process.

13 Emerging Regional Plan Water Resources South East Consultation Response Document. May 2022. WRSE

9.13 A high-level summary of stakeholders' views and how they have been reflected in the work undertaken is set out in Table 9-1. A detailed breakdown of stakeholder views is set out in "Stakeholder Engagement and Customer Report" Annex.

Table 9-1 Feedback from engagement

Stakeholder	Summary of the main points of feedback	How addressed/being addressed
Regulators and relevant prescribed consultees (EA, NRW, NE)	Approach to assessing river water quality, BNG, natural capital, WFD and SEA. Specific concerns regarding compliance risk associated with Habitats Directive on the Severn Estuary SAC, compliance with Environment (Wales) Act 2016 and Well-being of Future Generations (Wales) Act 2015 (EA NE, NRW).	Ongoing engagement with regulators to work through the different environmental assessments, including evidence base that would be required to demonstrate that the integrity of the Severn Estuary SAC and compliance with the Environment (Wales) Act 2016 and Well-being of Future Generations (Wales) Act 2015 is not compromised by the STT. The STT SRO design has been altered to mitigate any potential adverse effects on the integrity of the Severn Estuary SAC and its functionally linked habitat,
Drinking Water Inspectorate	Apply appropriate drinking water risk assessment	Working with Drinking Water Quality DWQ water company teams a workshop was held with the Drinking Water Inspectorate to explain the approach to the drinking water assessment and seek additional feedback. The appropriate drink water assessment has been applied.
Local authorities (impacted by SRO)	Impact on River Severn flows and future water availability; BNG opportunities, partnership working; treatment works requirements; Interconnector optioneering methodology; pipeline construction working area; future engagement strategy.	Meetings held with local authority officers to explain the SRO, including explaining how the impact on the River Severn and water resource availability has been assessed, the design process and interconnector optioneering methodology. Engagement strategy and planning and consents strategy updated to reflect feedback. Technical officer workshops to be undertaken in Gate 3.
Environmental groups	Concerns over the long-term feasibility in the face of climate change and the complexities in terms of regulation; the potential adverse impacts on the river ecology from the transfer of invasive species; impact of a pipeline construction through the Cotswold AONB; suggestions of best practice for constructing pipelines through sensitive locations; energy recovery opportunities.	Meeting held with environmental groups to explain solution, the water resource assessment how the SRO would operate, optioneering, pipeline details and environmental assessment work. Pre-treatment of the raw water from the River Severn is proposed to ensure that there is a barrier to INNS transfer and that there is no deterioration in the River Thames raw water quality as a result of the transfer. Best practice and energy recovery suggestions to be considered in Gate 3 as part of detailed design work.
River interest groups	Concerns focused on potential adverse impacts on the river ecology from the transfer of invasive species, unwelcome changes in the quality and quantity of river flow, long-term feasibility in the face of climate change and the complexities in terms of regulation.	Meeting held with river groups to explain solution mitigation measures, including pre-treatment. Pre-treatment of the raw water from the River Severn is proposed to ensure that there is a barrier to INNS transfer and that there is no deterioration in the River Thames raw water quality as a result of the transfer. Wider benefit solutions suggested by stakeholders to be considered in Gate 3.
Welsh-focused stakeholders (including Wales Water Management Forum members)	Interest in whether SRO source options would impact Wales, particularly on flooding, invasive non-native species, water quality and impact on Severn Estuary. Specific question on whether the SRO would impact Vyrnwy reservoir.	In our presentations we explained that there would be no net increase in water abstracted from Vyrnwy reservoir as part of our SRO. We provided a description of our environmental studies and assessments to consider water quality and impact on the Severn Estuary. Further engagement planned for Gate 3 with local stakeholders to explain preferred Vyrnwy Bypass Pipeline option and alternatives.
Cotswold Canals-related groups	Consider a canal transfer offers much greater environmental, cultural, and social benefits than any of the other SROs. Sought further details on STT optioneering methodology, including options costs.	Detailed dialogue and sharing of information with Cotswold Canals Trust (CTT). CCT provided canal construction costs and engineering data, including details of lining techniques. Project team provided Interconnector Options Report summary to explain optioneering process. 1-2-1 meeting with CCT to explain Gate 2 optioneering outcomes, including costs. In Gate 3 there will be opportunity for stakeholders to feedback on options methodology, options selection and Interconnector corridors selection.

GARD	Support for water transfer between Severn and Thames. Sought additional details on reasons why greater source yields and Deployable Outputs could not be achieved.	Meetings held and evidence provided to GARD to explain reasons why greater source yields and Deployable Outputs could not be achieved. In Gate 3 there will be an opportunity for stakeholders to feedback on options methodology, options selection and Interconnector corridor selection.

Customer preference studies

9.14 This section presents the engagement with customers as part of regional planning and SRO specific research. The Gate 1 engagement focused on examining customers' views on water resources planning – the challenges, the options, sharing resources and the strategic regional options including water transfers. The key points in relation to transfers were support for collaboration on planning future water resources; a lower preference for water transfers than some other options such as reservoirs; in general transfers via river or canal were considered to be more appealing than pipeline options; with main concerns for transfers raised on cost, construction disruption, environmental impact, energy use, lack of local community benefits, and water quality. This has led to more detailed research on potential changes to customers' source of water and additional value that could be provided as part of investment in water resource schemes.

Regional customer research studies

9.15 WRW reviewed the quantitative and qualitative customer research from all the WRW water companies including on aesthetics, source preference and transfers. For a qualitative analysis, a thematic analysis of 57 pieces of research was undertaken, mainly from company PR19 and WRMP customer research.

9.16 On behalf of water companies in the South East, WRSE carried out research with more than 2,500 domestic and business customers across the region. The research sought to understand which options customers prefer to supply their water. The research is being used to develop a customer preference score which will be used as part of its best value assessment.

9.17 The STT project team have supported WRW and WRSE in their customer research studies, for example by providing details on the project scope, solution design and options. From reviewing customer research undertaken by WRW and WRSE, it can be concluded that customers see a role for water transfer schemes and favour them over other supply options such as desalination and groundwater abstraction. Customers want resources that are reliable, avoid environmental harm, are not energy hungry, and provide wider benefits, including benefits for local amenity. Water transfers are seen as sensible and inexpensive as long as they are not to the detriment of the donor and environment. However, customers have a perception that water transfers could shift water availability problems around the country rather than dealing with them directly. Welsh customers favour sharing water within Wales but are less positive about sharing further afield.

Wider benefits study

9.18 This research study was undertaken as a "club project," a collaboration across 11 SROs. It aimed to understand what added value our customers perceive is important; to understand preferences for the added value; and to determine if the preferences change, depending on the geographical location/type of scheme or other factors. It also sought to establish how much customers are prepared to pay; and determine the nature of the language we should use to explain the added value to customers.

9.19 The engagement included both a qualitative and quantitative phase. The qualitative research showed that the concept of "public value" needed to be explained; it is not a commonly used term, but once the concept was understood, the majority of people felt that it is important. However, most are "contingent supporters" i.e., they need convincing that additional costs are justified, particularly in the current economic climate.

9.20 The quantitative research indicated participants willingness to pay for a set of potential project additions in the context of the SROs. For households, the highest-valued project additions for sites that are five miles away from the home were specialist habitats created for wildlife. For non-households, the highest-value project additions were a sensory garden/space for those with learning difficulties, followed by specialist habitats created for wildlife.

Changes to source water study

9.21 This was a collaborative project across 11 of the SROs with the aim of understanding customers' views on changing their water source. It comprised three stages of research:

- A review of existing evidence to understand attitudes towards water source change.
- A qualitative phase to explore customers' views about water resource options, taste tests using samples representing a range of source options and engagement on how to communicate changes to water sources for each option type including content, tone of voice, timing and format. Ninety-six household customers were engaged in this phase.
- Quantitative testing of draft communications using different framings; 1,762 customers and 198 non-household customers were engaged during the quantitative phase.

9.22 In respect of water transfers, concerns arose from comprehension issues, for example many customers struggle to understand the logistics and infrastructure required for water transfer. There were also worries about water quality, with customers stating they have some sense that the taste or characteristics of their water may change if it is coming from a different area of the country. However, the product sample tasting reassured customers that water transferred from other areas will not necessarily taste noticeably different from what they are used to. The environmental impact of transfers was also raised, specifically on the potential disruption of natural habitats.

Water quality (Severn Trent Water water quality customer research)

9.23 Severn Trent Water commissioned a survey to measure customers' perceptions of water quality and views on switching water sources, with a specific focus on customers from Oswestry and Shrewsbury, as these customers would experience a change in tap water as a result of the SRO.

9.24 From the research, when looking at future water supplies, a third of households that participated in the survey who were from Shrewsbury and Oswestry would accept their water coming from another source in exchange for softer water. Similarly, the majority of customers do not mind Severn Trent Water switching sources in a prolonged dry period even if it impacts water quality.

9.25 Further detail on all these studies can be found in the Stakeholder Engagement and Customer Engagement Report Annex. It is also noted that customer research was carried out by United Utilities regarding the perceptions regarding the switch in water sources to facilitate the Vyrnwy source; this is reported in the North West Transfer SRO.

Details of the engagement with customers directly affected by the solution, such as those living or working nearby

9.26 Stakeholders directly affected by the solution will be engaged during Gate 3. At Gate 3, the preferred pipeline route option and alternatives will be in sufficient detail with local stakeholders having the opportunity to provide meaningful feedback which can inform and influence the SRO development through Gate 3 and beyond.

Evidence of engagement with the Consumer Council for Water

9.27 WRSE and WRW have facilitated a regional Customer Challenge Group, bringing representatives from the Consumer Council for Water and the company independent challenge groups to share and input on the approaches and materials used to engage customers. Both the Consumer Council for Water and the DWI have been engaged as part of the collaborative research activities.

Transparency for customers and stakeholders

9.28 We have engaged and communicated with key stakeholders at the appropriate project programme junctures to ensure we have given them the opportunity to understand the project, feel part of the process, and enable them to provide feedback that can help inform our decisions and future planning.

9.29 In our engagement activities, which we have embedded across the Gate 2 process, we have provided key project facts and simple diagrams to explain the SRO. We have communicated clearly how the project aligns with the progress of the WRSE, WRW, and company WRMPs. We have updated key stakeholders as our optioneering has progressed and signposted to stakeholders our future programme of activities. We have also asked stakeholders how they would like to be engaged going forward.

9.30 We will ensure a range of engagement methods are in place for Gate 3 that are inclusive of everyone. This will reflect on the feedback received from stakeholders from Gate 1 and Gate 2. To aid

transparency, and as an integral part of approach to best practice, a draft Statement of Community Consultation will be prepared and consulted upon as pursuant to the requirements of the Planning Act 2008.

9.31 Table 9-2 summarises the stakeholder feedback raised in Gate 1 and how they have been considered in Gate 2 or will be addressed at future stages.

Table 9-2 Gate 1 stakeholder feedback

Topic	Stakeholder	Summary of representation	STT responding action
Water loss	Colne Valley Fisheries Consultative	Concern over risk of a net loss of water between the two rivers with increased risk of drought impacting both catchments.	Net loss of water and the risk of droughts impacting both catchments have been considered in Gate 2. For Gate 2 losses have been assessed to be 2% for the River Thames. Loss assumptions will be investigated and reviewed in Gate 3. The Minworth and Netheridge options provide resilience against risk of drought in both catchments. Chapter 4 of the Gate 2 report summarises the water resource assessment, including how water losses and droughts impacting both river catchments have been considered.
INNS	Colne Valley Fisheries Consultative	Risk of INNS spreading between catchments.	Pre-treatment of the raw water from the River Severn is proposed to ensure that there is a barrier to INNS transfer and that there is no deterioration in the River Thames raw water quality as a result of the transfer. Chapter 6 of the Gate 2 report summarises the solution environment assessments. An INNS assessment is included in the Annexes
Transparency and Deployable Output	GARD	Concerns over a lack of transparency in solution cost estimate, Deployable Output, and flow data.	Meetings held between project representatives and GARD to respond to their concerns. Chapter 3 of the Gate 2 report summarises the solution development. A Concept Design Report is set out in the Annexes. Chapter 8 of the Gate 2 report summarises the solution costs and benefits. A number of models, as detailed in Table 4-1, have been used to understand the Deployable Output (DO) benefit of STT. They were also used to understand its utilisation, the pre-optimisation of its source options and its interaction with the United Utilities and Severn Trent Water systems, and River Severn Regulation. Details of the proposed Deployable Output (DO) and an explanation as to why the DO has been selected, and the approach to river losses, are set out in Chapter 4 of the Gate 2 report.
Carbon	GARD, South Oxfordshire Council (SODC) and the Vale of White Horse (VWH)	GARD highlight concerns over shortcomings of carbon data. SODC state the pipeline may involve pumping water uphill which could require significant amounts of energy. SODC and the VWH state that the scheme's carbon footprint should be made public.	The carbon assessments methodology for the STT SRO have followed PAS2080 principles. Carbon has been modelled for each of the pipeline options both embedded carbon and operational carbon. Chapter 6 of the Gate 2 report summarises the solution environment assessments, including on carbon. The detailed carbon appraisal is set out in the Annexes.
Phasing	GARD	Consideration given to combining the unsupported transfer with Mythe bringing in Vyrnwy regulation to a level that requires minimal new source development for UU.	Optimisation modelling has been undertaken in Gate 2 to establish the optimum phasing of the sources. Chapters 3 and 4 of the Gate 2 report summarise the solution development. They highlight the engagement with donor water companies on optimising the phasing of sources to support the transfer of water to the River Thames.

Interconnector	GARD, Oxfordshire County Council (OCC)	GARD support the use of the Cotswold Canals if it can be shown that a 300 Ml/d transfer is sufficient, and the canal is a better option than transferring via the pipeline from Deerhurst. OCC favour the use of existing or refurbished infrastructure, such as the canal transfers, or infrastructure which is underground, such as pipes.	The partial refurbishment of the Cotswold Canals has been considered within an Interconnector Options appraisal undertaken in Gate 2. The Interconnector Options Appraisal selected a preferred Interconnector option that would transfer water from the River Severn to the River Thames through the Deerhurst Pipeline. Chapter 3 of the Gate 2 report summarises the solution development, including the options considered for the Interconnector. The Interconnector Options Appraisal, with a summary report is submitted as in the Annexes. It is noted that the 500Ml/d interconnector option is being chosen in the draft regional plan rather than a 300Ml/d transfer.
Vyrnwy Release	GARD	GARD requested a rigorous and transparent investigation into the 'Deerhurst Hands off Flow'; suggested releases of up to 400 Ml/d are considered in Gate 2 for Lake Vyrnwy and a water balance approach considered for assessing river losses between Vyrnwy and Deerhurst.	The environmental and permitting considerations relating to the release limitations from Lake Vyrnwy are detailed in Chapter 6 and 7 respectively. It is noted that GARD have opened dialogue directly with the regulator on this matter.
Water resource need	Oxfordshire County Council (OCC)	Consider option should only be pursued with a full understanding of the forecast need for additional water and the water savings that can first be achieved.	Forecasted need for additional water, and proposed water savings, including leakage reduction and water efficiency measures, are set out in the regional plans and water company WRMPs. The STT SRO has been included in the regional plan modelling and is on the preferred and alternative pathways in the draft regional plans. The Water Resources South East (WRSE) emerging draft regional plan has selected a 500Ml/d interconnector option as the preferred transfer with sources phased over the life of the plan.
Procurement, ownership, and operation	GARD	There is no consistent view on how the transfer, and its components, should be procured, owned and operated.	The Gate 2 process has concluded that while the STT System is not considered to be suitable as a DPC in its entirety, the Interconnector is seen as an element of the System which is suitable for a DPC. Thames Water are considered the party who would take forward the delivery of the Interconnector as the Appointee. Chapter 7 of the Gate 2 report summarises the solution programme, procurement, and planning. Further work on procurement, ownership and operation of the solution will be undertaken in Gate 3.
Environmental effects	Oxfordshire County Council (OCC), South Oxfordshire Council (SODC), and the Vale of White Horse (VWH)	OCC highlighted the need for further assessment of social, economic and amenity costs and benefits. SODC and the VWH highlight there could be significant environment impacts and state it's not clear if the solution could achieve biodiversity net gain.	A wider multi-sector benefits analysis has been undertaken as part of the interconnector options appraisal analysis and 'potential futures' assessment. This analysis includes social, economic and amenity costs and benefits. The potential environmental effects of implementing and operating the STT SRO have been considered. Across all topics, environmental impacts have been avoided or mitigated, and opportunities for enhancements have been highlighted. Where uncertainty remains, recommendations have been made to address them in Gate 3. A Natural Capital & Biodiversity Net Gain (England) Assessment and Welsh Biodiversity Duty and SMNR Assessment have been undertaken. An assessment of 'uplift'

			necessary to achieve a minimum of the required 10% BNG has also been calculated. Chapter 6 of the Gate 2 report summarises the solution environment assessments. The Annexes provide a suite of environmental appraisals and assessments, including biodiversity net gain and wider benefits.

9.32 Between Gate 2 submission and Gate 3 approval, we plan to undertake the following activities:

- continue targeted engagement with key stakeholders;
- support WRMP and regional plan consultations;
- draft stakeholder engagement resource plan;
- draft landowner engagement plan.

9.33 For Gate 3, stakeholder engagement will be accelerated. This will include introducing the project to local communities, engagement with landowners impacted by the SRO, and detailed engagement with technical stakeholders. A summary of the approach to stakeholder engagement in Gate 3 is set out in the Next Steps section of the "Stakeholder Engagement and Customer Report" Annex.

10 Board statement and assurance

Assurance approach

10.1 The assurance framework used for this submission has been developed jointly by Thames Water, United Utilities, and Severn Trent Water and is a continuation of the process used for Gate 1. To ensure that we stayed aligned in our approach, the Assurance Leads for the three companies met on a regular basis during the production and assurance of the Gate 2 submission.

10.2 The risk-based assurance approach employed is consistent with that documented in the individual companies' statements of reporting risks, strengths, and weaknesses and final assurance plans for 2021 – 22 and is based on a shared understanding of the three lines of assurance model shown in Figure 10-1. It is also consistent with the assurance requirements laid out in Ofwat's Company Monitoring Framework.[14]

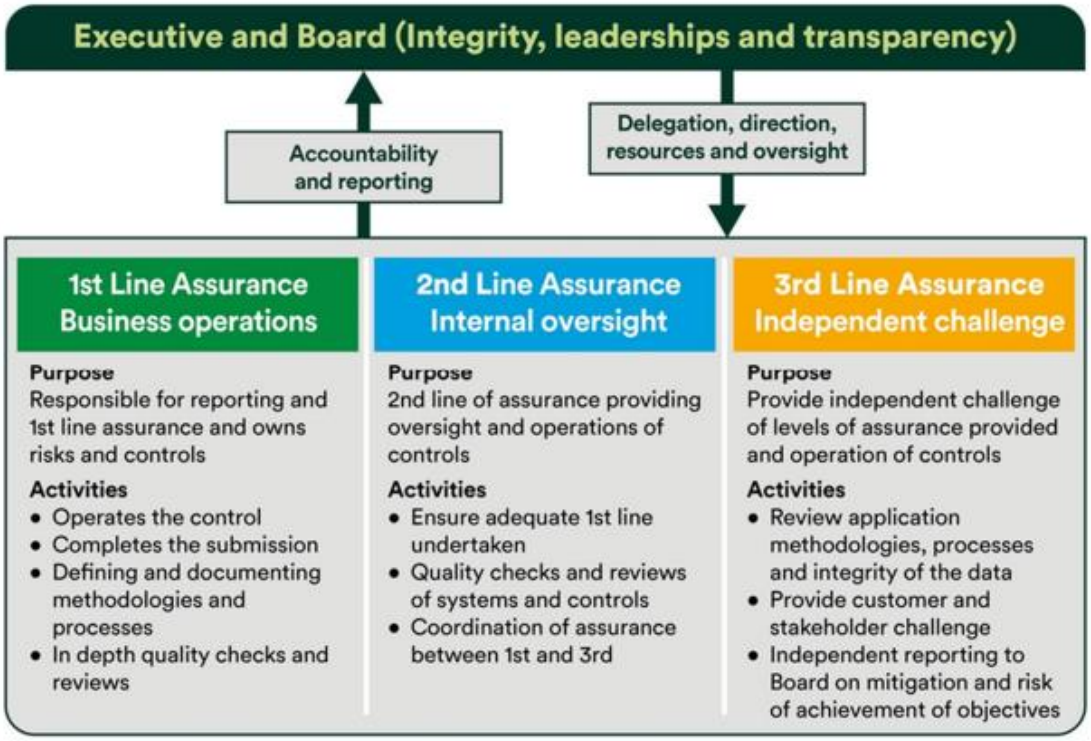


Figure 10-1: Risk assessment and assurance approach

14 The latest iteration of Ofwat's Company Monitoring Framework can be found on their website through the following link: http://www.ofwat.gov.uk/publication/company-monitoring-framework-final-position/

10.3 This approach provides an effective programme of assurance. It considers areas that we know are of prime importance to our customers and regulators, or may have a significant financial value, alongside the likelihood of reporting issues. Areas of higher risk received three lines of assurance, while other areas, where the risk is lower, were targeted with first- and second-line assurance only.

10.4 For the environmental activities at Gate 2 we also procured an independent 'environmental advisor' to provide oversight and independent review of the environmental deliverables. This was in addition to the environmental regulator and company reviews, providing additional, detailed and progressive assurance in this area.

10.5 Our approach was augmented by experience that the companies gained through the Gate 1 assurance process and the sharing of best practice.

Overview of assurance scope and findings

10.6 External assurers were appointed and the specific objectives of the independent assurance were to:

- confirm that the requirements set out in Ofwat's final determination and subsequent additional feedback from Ofwat have been met.
- confirm that the companies comply with RAPID's reporting requirements and guidelines.
- ensure that the companies' material assumptions and methodologies have been disclosed and explained.
- be satisfied that the work that has been carried out is consistent with the stated methods, procedures, policies and assumptions.
- has been subject to sufficient processes and internal systems of control to ensure that the information on design, costs and benefits contained in this submission is reliable; and
- has been appropriately assured to give STT's stakeholders, including customers, trust, and confidence in the Gate 2 submission.

10.7 Based upon their audits and review of the information provided, the assurers concluded that the STT submission satisfies the Gate 2 and met the required objectives.

Board assurance statements

10.8 Please see the covering letter where the signed Board Assurance Statement is provided including the evidence considered by the Board.

11 Efficiency of expenditure for Gate 2 and forecast

11.1 The STT SRO has been efficiently delivered within the budget for Gate 2, with an underspend against the Gate 2 final determination allocation of circa 30%.

11.2 The RAPID budget for the STT SRO at Gate 2 is £9.99m (2017 / 2018 price base) and is shared in equal thirds between the three STT partner companies.

11.3 The total cumulative expenditure for Gate 1 and Gate 2 activities is summarised in Table 11-1.

Table 11-1 Summary of Gate 1 and 2 expenditures

Activity	Funding allowance (£,000) 2017/18 price base	Expenditure (£,000) Actuals	Expenditure (£,000) 2017/18 price base	Percentage of expenditure against funding allowance
Gate 1 actual expenditure	£6,660	£4,494	£4,014	60%
Gate 2 forecast expenditure	£9,990	£7,865	£7,205	72%
Total	£16,650	£12,360	£11,219	67%

11.4 The STT SRO remains one of the most complex in the RAPID SRO programme. It is delivered through three equally funded partner companies (two "sellers" and one "buyer"). There are integral dependencies with the three source SROs, two regional interfaces (one "donor" and one "recipient" region) and it affects both England and Wales with associated stakeholder and legislative considerations. There is a requirement for an overarching "system" view to be taken across a range of engineering, environmental, consenting, permitting, stakeholder and commercial considerations which cuts across the STT SRO and source SROs.

11.5 As was the case at Gate 1, the STT system complexity and multi-partner involvement has demanded a clear structure, defined processes, and joint ways of working. This has avoided duplication of effort or a siloed approach and utilised the strengths of the team members to ensure efficient use of core team activities and overall programme management. The SRO has continued to employ programme structures, processes and partner governance that reflects the complexity and multi-partner involvement and promotes efficient Gate 2 delivery.

11.6 The workstream activities are solely in respect of specific STT system activities. Costs for other SRO activities and other company activities, including regional and WRMP24 planning, are not included in expenditure for STT Gate 2 activities.

11.7 Where applicable, company overhead has been charged to the elements of the company's STT spend with the overhead then allocated in proportion to workstream costs.

11.8 Excluding internal in-company, regulator charges, overheads, and other similar items that are not appropriate to procure, activities have been procured under company frameworks with over 85% of activities (by value) subject to scope-specific procurement competitions across company framework suppliers.

11.9 We have undertaken a comparison across SROs for consistency in costs incurred for each work breakdown structure element. This has shown generally good alignment across SRO's when the different nature of some of them is factored in.

11.10 The Gate 2 expenditure has been subject to both internal and external third-party assurance which has verified the efficient and relevant expenditure of STT Gate 2 activities. This has been reviewed separately by the companies in support of company board approval for the Gate 2 submission.

Breakdown of company governance and project management activities

11.11 The Gate 2 expenditure against company governance and project management activities is provided in table 11-4 under 'Governance (tripartite company cost)' and 'Programme Management' activities.

11.12 Programme governance activities ("tripartite") were similar to those reported in Gate 1 but with an increased focus at Gate 2 on commercial aspects of the programme, both the long-term commercial operation and procurement models, and participation post-Gate 2.

11.13 Programme management was provided through a competitively procured senior, independent programme manager. This role was supported where required by part-time resource principally leading cost reconciliation and forecasting activities. The Programme Manager position was procured following a tendering process at Gate 1 utilising all three companies' frameworks. To provide continuity and efficiency this commission was extended under the same tendered commercial terms into Gate 2.

11.14 The programme management activities were largely similar to those undertaken at Gate 1, again with an increased focus on managing the development of post-Gate 2 commercial aspects.

11.15 Table 11-2 summarises the breakdown of the principal activities and estimated % level of effort.

Table 11-2: Summary of split of tripartite company governance and programme direction activities

Activity	Estimated level of effort % split
Standing meetings/calls	10%
Commercial and programme oversight	20%
Technical oversight and assurance	30%
Stakeholder	10%
Cross company/SRO support	10%
In-company governance activities	20%

11.16 Table 11-3 summarises the breakdown of the principal activities and estimated level of effort.

Table 11-3: Summary of split of programme management activities

Activity	Estimated level of effort % split
Programme Management and programme support	30%
Work package procurement	15%
Technical	30%
Commercial model/post-Gate 2 planning	10%
Other activities	15%

Thames Water Client team costs

11.17 For Gate 3, it is proposed that Thames Water will be accountable for the development and delivery of the Interconnector. Thames Water has established an internal Client team to manage its portfolio of SRO projects. During Gate 2, that team has been engaged in the development, review and assurance of the Gate 2 submissions, the development of plans for Gate 3, procurement of ongoing consultancy support and stakeholder engagement, across the Thames Water SRO portfolio.

11.18 For Gate 2, the total cost of the Thames Water Client team's work related to STT is approximately £300k (2017/18 base) and is allocated to relevant activities in table 11-4. Severn Trent and United Utilities, as providers of water, are not exposed to the same delivery risk as Thames Water and their costs are less as a result.

11.19 Separately, Thames Water has written to RAPID, with the support from STW and UU proposing that some Gate 3 activities commenced in August 2022. RAPID has advised[15]that such costs should be accounted for as GATE 3 expenditure and are not included in Table 11-4.

Summary of Gate 2 expenditure

11.20 A breakdown of Gate 2 expenditure is set out in Table 11-4. Incurred costs for the gate activity are presented in the 2017/2018 price base and in accordance with the RAPID Gate 2 efficiency of spend template. Additional breakdown is provided for any spend categories that exceed £0.5 million in value.

Gate 3 and Gate 4 funding requirements

11.21 Table 11-5 provides a summary of the current Price Review 2019 (PR19) final determination funding for the STT SRO. This is on the basis that the underspend from Gate 1 and Gate 2 can be carried forward into Gate 3 and Gate 4.

11.22 Table 11-6 summarises the estimated funding requirements for the STT SRO at Gate 3 and Gate 4. This indicates that the current PR19 funding of £66.6m is sufficient to cover STT activities to the end of AMP7.

11.23 If the STT SRO progresses beyond the Gate 3, the funding for Gate 4 activities, to be undertaken in AMP 8, would be agreed with RAPID and reflected in PR24.

15 Email from RAPID to Thames Water, 'Thames Water SRO advanced Gate 3 spend proposal', 2nd September 2022 in response to Thames Water letter 'Early Gate 3 Expenditure', 18th August 2022.

Table 11-4 Breakdown of Gate 2 expenditure

Category	Activity	Expenditure 2017/18 price base	% of total expenditure	Description of activity
Programme & project management	**Total**	**£929,924**	**12.9%**	
	Programme management	£385,042	5.3%	Full-time programme manager and plus part-time support
	Governance (tripartite company cost)	£473,938	6.6%	Company PMB governance and management activities. This is split three ways between United Utilities Severn Trent and Thames Water.
	Assurance	£70,944	1.0%	Independent third line assurance & part-time assurance coordinator
Feasibility assessment and concept design	**Total**	**£918,801**	**12.8%**	
	Systemwide design and technical lea	£474,927	6.6%	Systemwide engineering including regional/WRMP24 STT data submissions & updates; operational strategy; permitting strategy; overall SRO cost management and reporting; Gate 2 report delivery; overall technical co-ordination.
	Interconnector design development	£166,606	2.3%	Design development and costings of preferred Interconnector option
	Bypass + Shrewsbury design development	£277,268	3.8%	Design development & costings of preferred Bypass & Shrewsbury supply options
Option benefits development and appraisal	**Total**	**£1,000,110**	**13.9%**	
	STT water resources system model	£305,213	4.2%	Development of a linked Pywr STT system model and initial runs for Gate 2
	Severn losses	£116,804	1.6%	Additional River Severn losses investigations including ungauged tributaries, correlation analysis and antecedent conditions.
	DO and utilisation analysis and modelling	£61,573	0.9%	Detailed review of DO & stochastics for STT
	Interconnector options appraisal	£429,277	6.0%	Detailed appraisal of interconnector route and site options, including 'potential futures and stakeholder technical engagement
	Bypass design + Shrewsbury options appraisals	£87,243	1.2%	Detailed route and supply options appraisal of Bypass and Shrewsbury
Environmental assessment	**Total**	**£1,949,443**	**27.1%**	
	Environmental Advisor	£64,600	0.9%	Independent oversight and review of all environmental deliverables
	Environmental Assessments:			
	BNG, NC, HRA, WFD, SEA, SMNR	£356,297	4.9%	Environmental methodologies, evidence reports & assessments
	Engineering scheme inputs	£113,667	1.6%	Environmental inputs into Interconnector, bypass, and Shrewsbury
	Other	£175,070	2.4%	Vyrnwy direct release, outfall locations & chemical determinants of fish
	Environmental Lead	£151,950	2.1%	Cross system co-ordination including interfaces with regulators & SROs
	Wider benefits study	£76,100	1.1%	Investigation into wider opportunities based on 6-capitals approach
	Water quality modelling	£342,669	4.8%	River Vyrnwy, Avon, and Severn water quality model development and runs
	Regulators and Regional charges:			
	Natural Resources West (NRW)	£83,799	1.2%	Regulator charges are subject to variation based on final out-turn
	Natural England	£90,096	1.3%	Regulator charges are subject to variation based on final out-turn
	EA Including NAU	£466,129	6.5%	Regulator charges are subject to variation based on final out-turn
	WRSE, WRW regional charges	£29,063	0.4%	Regional charges for specific STT-related activities undertake on behalf of the SRO for efficiency and consistency purposes by the region.
Data collection, sampling, and pilot trials	**Total**	**£1,613,970**	**22.4%**	
	Aquatic ecological monitoring	£245,099	3.4%	Includes fish, macrophytes, macroinvertebrate, INNS, diatoms for rivers
	Protected species (summer 2021 surveys)	£109,854	1.5%	Plant, protected species, and protected habitat surveys on the rivers
	Physical/water quality monitoring for Gate 2 reporting	£497,460	6.9%	Sondes, water quality sampling and testing for over 20 sites until April 2022
	Continued monitoring (spring/summer surveys 2022)	£40,944	0.6%	Fisheries, mussels, weir pool habitats,
	Physical/water quality monitoring	£485,126	6.7%	Continuation post-April 2022, sondes, water quality sampling and testing
	Algae and PFAS monitoring	£235,486	3.3%	Algal and PFAS sampling and testing including flow cytometry
Procurement strategy	**Total**	**£380,036**	**5.3%**	Developing commercial operating model and procurement approach
Planning strategy	**Total**	**£115,666**	**1.6%**	Developing planning consents strategy, including land
Stakeholder engagement	**Total**	**£140,962**	**2.0%**	Three customer research activities & stakeholder management
Legal	**Total**	**£156,829**	**2.2%**	Detailed legal reviews of Interconnector options, planning strategy & Gate 2 documentation including three company legal team inputs.
Other	**Total**	**£0**	**0%**	
Total		**£7,205,743**	**100.0%**	
Funding allowance:				
Gate 2 Allowance (G2 underspend)		£9,990,000 (£2,784k)	72%	
Gates 1 & 2 total spend: Gates 1 & 2 allowance (G1&G2 underspend)		£11,219k £16,650k (£5,430k)	67%	

Table 11-5 STT PR19 funding allowance

Gate	STT SRO PR19 Funding	Cumulative funding	Cumulative funding less Gate 1 and 2 forecast expenditure**
Gate 1	£6,660	£6,660	-
Gate 2	£9,990	£16,650	£5,450
Gate 3	£23,310	£39,960	£28,760
Gate 4	£26,640	£66,600	£55,400
** Gate 1 and Gate 2 outturn spend is estimated at £11,200 All values are reported in £,000 and 2017/18 price base.			

11.24 A breakdown of the estimated Gate 3 forecast expenditure in accordance with the RAPID template is provided in the Efficiency of Gate 2 spend and forecast Annex.

Table 11-6 Estimated Gate 3 and Gate 4 funding requirements

Gate	Estimated Funding requirements			Cumulative Estimated Funding requirements	Cumulative funding	Estimated cumulative funding shortfall
	Interconnector Development	Bypass, System Coordination	Total			
Gate 1 & 2	£11,200	-	**£11,200**	£11,200	£16,650	
Gate 3	£38,100	£11,400	**£49,500**	£60,700	£39,960	**£20,740**
Gate 4	£25,200	£7,550	**£32,750**	£93,450	£66,600	**£26,850**
Total	**£63,300**	**£18,950**	**£93,450**	-	-	-
All values are £,000 and 2017/18 price base						

11.25 As set out in Chapter 7, for Gate 3 the accountabilities of the STT partners will change with:

- All three partners responsible for the System Co-ordination
- All three partners responsible for the Bypass development
- Thames Water responsible for the interconnector development

This will attract a commensurate change in partner liabilities, including any penalties as may be determined by RAPID.

11.26 It is proposed that the Gate 3 funding split between companies to the end of AMP7 is changed to match the allocation of accountabilities, with a funding allocation of approximately 80% to Thames Water and 10% each to Severn Trent and United Utilities.

11.27 No changes to the proposed penalty scale, delivery incentives, assessment criteria or contributions are currently proposed for the Gate 3.

12 Conclusions and recommendation

12.1 The STT SRO is an ambitious and scalable option that will provide resilience to a 1 in 500-year drought.

12.2 The sources of support water are being provided by United Utilities and Severn Trent Water who are working in collaboration with Thames Water to develop this solution. The sources are detailed below and represent an increase on the support volume of 25Ml/d when compared to Gate 1:

- Lake Vyrnwy: Utilisation of up to 180Ml/d of water licensed to United Utilities from Lake Vyrnwy (facilitated by North West transfer SRO) by two separate means:
  - a direct release of 25Ml/d of water into the head of the River Vyrnwy;
  - a release of 155Ml/d of water into the existing Vyrnwy Aqueduct/ Oswestry with a new bypass pipeline that connects it to the River Severn, thus mitigating any environmental impacts in the River Vyrnwy;
- Shrewsbury Redeployment: the provision of 25Ml/d of treated water supply to Shrewsbury from the North West Transfer SRO. This will release flows into the River Severn that were previously abstracted to supply Shrewsbury.

- Mythe: Temporary transfer of 15Ml/d of Severn Trent Water -licensed abstraction at Mythe, thus releasing flows to the River Severn;
- Minworth: The transfer of 115Ml/d of a highly treated wastewater discharge from Severn Trent Water's Minworth WwTW to the River Severn via the River Avon; and
- Netheridge: The transfer of 35Ml/d of a highly treated wastewater discharge at Severn Trent Water's Netheridge WwTW to a new location upstream of the current discharge to the River Severn. To ensure flows are provided to the Interconnector for all river conditions, Netheridge has been identified as the source for the 20Ml/d sweetening flow.

12.3 We have selected a direct release of 25Ml/d into the River Vyrnwy to avoid impacts on the environment while still allowing sufficient headroom for the required compensation releases as stipulated by the 1880 Act. No works are proposed in Wales.

12.4 Inputs have been provided to the regional plan modelling and the STT is on the preferred and alternative pathways in the Draft Regional Plans for both WRW and WRSE.

12.5 Following a thorough and robust options appraisal process the Interconnector concept design has advanced. The Deerhurst Pipeline is currently preferred for the transfer infrastructure as it meets the preferred transfer capacity and provides the best value solution. However, we will consult on our preferred option and alternatives in Gate 3.

12.6 The timeline for Gate 3 is based on ensuring STT could be "construction ready" in AMP8 (2025 to 2030) if required. However, other later delivery timescales may be appropriate which will be confirmed once the regional and WRMP24 plans are finalised in 2023. A flexible approach is therefore proposed with a "Mid-Gate3 Checkpoint" at the end of 2023 to confirm and adjust the direction of the project, as appropriate, once the WRMP24 plans are finalised.

12.7 The regional planning process will determine the timing and utilisation of water to be transferred. Current projections from WRSE suggest that the unsupported flows will be required by 2050 with support sources coming online thereafter.

12.8 NRW has confirmed the maximum release from Lake Vyrnwy permitted under existing Acts and Orders is 405Ml/d. The proposed release direct from Lake Vyrnwy falls well within this limit. The interpretation of this is that there is no requirement to seek to amend the Liverpool Corporation Waterworks Act (1880 Act) in order to permit STT. A permitting road map has been developed in consultation with regulators to support the SRO development.

12.9 We have broadened our stakeholder engagement through Gate 2, engaging with interest groups, local authorities, and Welsh stakeholders. The transfer is receiving positive support and we are reflecting stakeholder feedback in our plans.

12.10 We have developed a commercial and operational strategy for this system which will mature through Gates 3 and 4.

12.11 The project finances have been carefully managed through Gate 2. This has been achieved by adopting a lean core management team and partnering with others to procure work with common scope and objectives. Competitive tendering has been used for 85% of the supply chain workstream activities. This cost-efficient approach has resulted in over 30% saving when compared to the budget.

12.12 No material issues have been identified in any of our assessments during the Gate 2 process.

Recommendation

12.13 This SRO should advance to Gate 3 where the activities identified in this report and work on regional planning will provide greater definition to the SRO proposal.

13 Supporting documentation

The following supporting information is provided to this Gate 2 submission.

Annex Reference	STT ID	Annex Title
A1.1	STT-G2-S3-303	Interconnector Deerhurst to Culham pipeline conceptual design report
A1.2	STT-G2-S3-331	River Vyrnwy bypass pipeline conceptual design report
A1.3	STT-G2-S3-302	Interconnector Options Appraisal Summary Report
A2 Annex Ref not used	STT ID not used	Annex Title not used
A3.1	STT-G2-S3-357	STT Cost Report
A3.2	STT-G2-S3-360	Carbon Strategy Report
B1.4	STT-G2-S3-103	Environmental Assessment Methodology Paper
B2.1	STT-G2-S3-104	Physical Environment Evidence
	STT-G2-S3-104-1	Physical Environment Workbook
B2.2	STT-G2-S3-105	Water Quality Evidence
B2.3	STT-G2-S3-106	Fisheries Evidence
	STT-G2-S3-106-1	Fisheries Evidence Workbook 20220930
B2.4	STT-G2-S3-107	Macroinvertebrates / Other Freshwater Ecology Evidence
	STT-G2-S3-107-1	Diatom Evidence Workbook 20220930
	STT-G2-S3-107-2	Macroinvert Evidence Workbook 202209030
	STT-G2-S3-107-3	Macrophyte Evidence Workbook 20220930
B2.5	STT-G2-S3-108	INNS Evidence
	STT-G2-S3-108-1	INNS Evidence Workbook 20220930
B2.6	STT-G2-S3-109	Protected Habitats Evidence
	STT-G2-S3-109-1	Evidence Report Protected Habitats 20220930
B2.7	STT-G2-S3-123	Protected Species Evidence
	STT-G2-S3-123-1	Protected Species Workbook 20220930
B2.8	STT-G2-S3-110	Biodiversity and Environmental Ambition Evidence
B3.1	STT-G2-S3-112	Physical Environment Assessment
	STT-G2-S3-112-1	Physical Environment Workbook 20220930
B3.2	STT-G2-S3-113	Water Quality Assessment
	STT-G2-S3-113-1	Water Quality Assessment Supporting Workbooks 20222101
B3.3	STT-G2-S3-114	Fisheries Assessment
B3.4	STT-G2-S3-115	Macroinvertebrates / Other Freshwater Ecology Assessment
B3.5	STT-G2-S3-116	INNS Assessment
B3.6	STT-G2-S3-117	Protected Habitat Assessment
B3.7	STT-G2-S3-124	Protected Species Assessment
B3.8	STT-G2-S3-118	Natural Capital & Biodiversity Net Gain (England) Assessment
		BNG-Annex1 20221001
		BNG-Annex 2-20221001
B3.9	STT-G2-S3-119	Ecosystem resilience, wellbeing & SMNR (Wales) Assessment
B4.1	STT-G2-S3-120	Initial Environmental Appraisal Report
	STT-G2-S3-120-1	Initial Environmental Appraisal - Annex A SEA Tables 20221011
	STT-G2-S3-120-2	Initial Environmental Appraisal-Annex B Heritage Assets 20221006
	STT-G2-S3-120-3	Initial Environmental Appraisal -Annex C - Risk Assessment 20221006
B4.2	STT-G2-S3-121	Informal Habitats Regulation Assessment (HRA)
B4.3	STT-G2-S3-122	Water Framework Directive (WFD) Assessment
	STT-G2-S3-122-1	WFD Assessment ACWG spreadsheet Full STT 20221005

	STT-G2-S3-122-2	WFD ACWG spreadsheet Early Phase 20221005
B5	STT-G2-S3-125	Wider Benefits Study
	STT-G2-S3-125-1	Wider Benefits Study - Annex 1 - 221005
C	STT-G2-S3-354	Strategic Water Quality Risk Assessment (SWQRA)
D	STT-G2-S7-701	Stakeholder and Customer Engagement Report
	STT-G2-S7-701-3	Annex 3. WRSE Best Value Criteria Customer Research Final Report May 2021 Optimized
	STT-G2-S7-701-4	Annex 4. Research to explore customer value preferences. Accent and PJM Economics. August 2022
	STT-G2-S7-701-5	Annex 5. Changing Water Sources. June 2022
	STT-G2-S7-701-6	Annex 6. Tap Water Quality Perceptions. May 2022
E	STT-G2-S5-501	Procurement, Ownership, and Commercial Operation Report
F	STT-G2-S3-356	Project Delivery Plan
G	STT-G2-S5-451	Planning, Consents, and Land Report
H	STT-G2-S6-601	Efficiency of Gate 2 Spend and Forecast